FORECASTING THE ARRIVALS AND PRICES OF OILEEDS IN CHHATTISGARH

M.Sc. (Ag) Thesis

by

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INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (Chhattisgarh)
2020

FORECASTING THE ARRIVALS AND PRICES OF OILSEEDS IN CHHATTISGARH

Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

Ankur Kumar Rathore

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Master of Science

in

Agricultural Statistics

V.V. ID No.: 20141518635 ID No. 120118052

JULY, 2020

CERTIFICATE - I

This is to certify that the thesis entitled **"Forecasting the Arrivals and Prices of Oilseeds in Chhattisgarh"** submitted in partial fulfillment of the requirements for the degree of **"Master of Science in Agriculture"** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Ankur Kumar Rathore** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or certificate course. All the assistance and help received during the course of the investigations have been duly acknowledged.

Date: 21-07-2020

Chairman

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman : Dr. A.K. Singh .....

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Member : Dr. A.K. Koshta .....

Member : Dr. R.S. Senger .....

CERTIFICATE - II

This is to certify that the thesis entitled **"Forecasting the Arrivals and Prices of Oilseeds in Chhattisgarh"** submitted by **Ankur Kumar Rathore** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the Department of Agricultural Statistics and Social Science (L.) has been approved by the external evaluator and Student's Advisory Committee after oral examination, under the chairmanship of Head of the Department.

Signature of Head of the Department

(Name..... Dr. A.K. Singh .....)

Date:- 21-07-2020

Major Advisor .....

Faculty Dean .....

Approved/ Not approved

Director of Instructions .....

Acknowledgement

First and foremost, I would like to thank God Almighty for giving me the strength, knowledge, ability and opportunity to undertake this research study and to persevere and complete it satisfactorily. Without his blessings, this achievement would not have been possible.

In my journey towards this degree, I have found a teacher, a friend, an inspiration, a role model and a pillar of support in my Guide, Dr. A. K. Singh, Professor & Head, Department of Agricultural Statistics and Social Science (L.), IGKV, Raipur (C.G.). He has been there providing his heartfelt support and guidance at all times and has given me invaluable guidance, inspiration and suggestions in my quest for knowledge. He has given me all the freedom to pursue my research, while silently and non-obtrusively ensuring that I stay on course and do not deviate from the core of my research. Without his able guidance, this thesis would not have been possible and I shall eternally be grateful to him for his assistance.

I pronounce utmost of gratitude to members of my advisory committee, Dr. G. Chandrakar, Professor, Dept. of Agricultural Statistics and Social Science (L.), Dr. A. K. Koshta, Professor , Dept. of Agricultural Economics and Dr. R. S. Senger, Professor, Dept. of Agricultural Extension for their valuable guidance and constructive criticism during the course of investigation.

I wish my grateful thanks to Dr. S. K. Patil, Hon'ble Vice Chancellor, Dr. R. K. Bajpai, Director Research Services, Dr. M. P. Thakur, Director of Instructions, Dr. G, K. Shrivastava, Director Students Welfare and Dr. S. S. Rao, Dean, College of Agriculture, IGKV, Raipur for providing necessary facilities, technical and administrative supports for conducting my research work.

I do express my heartliest thanks to the teachers of my department Dr. A. K. Singh, Dr. M. L. Lakera, Dr. Gayatri Chandrakar, Dr. R. R. Saxena, Dr. M. K. Pradhan & Dr. Sindhu Shukla for their constant co-operative suggestion, encouragement and help during my investigation.

I am highly thankful to all the non-teaching staff of my department namely, Shri P. B. Pradhan, Shri Subhash Agrawal, Sushma Raj and Chero for their help and co-operation.

It would be inappropriate if I omit to mention the names of my batchmates Abha, Abhishek & Sandra for cooperating me in my thesis work and my dear friends Manisha, Vivek, Jitendra & Nikhil who have, in their own ways, kept me going on my path to success, assisting me as per their abilities, in whatever manner possible and for ensuring that good times keep flowing. I also wish my warmest thanks to my respectful seniors Akhilesh Kumar Gupta & Chowa Ram Sahu who spared their valuable time and energy and extended their cooperation to me.

My acknowledgement would be incomplete without thanking the biggest source of my strength, my family. The blessings of my parents Mrs. Uma Devi Rathore & Mr. Chudamani Rathore and the love of my brother Akash Kumar Rathore, grandfather U.L. Rathore, grandmother Kamla Devi Rathore and cousins Akanksha, Kanha, Adarsh and Ashu who never let things get dull or boring, have all made a tremendous contribution in helping me reach this stage in my life. I thank them for putting up with me in difficult moments where I felt stumped and for

goading me on to follow my dream of getting this degree. This would not have been possible without their unwavering and unselfish love and support given to me at all times.

I would like to dedicate this work to my parents Mrs. Uma Devi Rathore & Mr. Chudamani Rathore whose dreams for me have resulted in this achievement and without their loving upbringing and nurturing; I would not have been where I am today and what I am today. It is true that if god ever existed, he would be in the form of parents, because only parents can love and give without expecting anything in return. I thank my parents with all my heart. This one is for you dear Mummy-Papa!

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Ankur Rathore
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AR	Auto Regressive
MA	Moving Average
ARIMA	Auto Regressive Integrated Moving Average
*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance
ha.	Hectare
qtl	Quintal
Rs.	Rupees
%	Percent
AIC	Akaike's Information Criteria
BIC	Bayesian Information Criteria
RMSE	Root Mean Square Error
MAE	Mean Absolute Error
MAPE	Mean Absolute Percentage Error

THESIS ABSTRACT

a)	Title of the Thesis	:	Forecasting the Arrivals and Prices of Oilseeds in Chhattisgarh
b)	Full Name of the Student	:	Ankur Kumar Rathore
c)	Major Subject	:	Agricultural Statistics
d)	Name and Address of the Major Advisor	:	Dr. A.K. Singh, Professor and Head, Department of Agricultural Statistics and Social Science(L.), College of Agriculture, Raipur (C.G.)
e)	Degree to be Awarded	:	Master of Science in Agriculture (Agricultural Statistics)

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Signature of the Student

Signature of the Major Advisor

Date: 21-07-2020

Signature of Head of the Department

ABSTRACT

Oilseed crops play a crucial role in the economy of India under agricultural sector which has diverse area under oilseed crops. In the State of Chhattisgarh, the oilseed crops, namely, groundnut, sunflower, niger, sesame, soybean, linseed, mustard-rapeseed are grown in its different parts.

For the development of agriculture it is quite necessary that farmers get good prices of their products in the agricultural markets. If there could be some forecast of arrivals and prices in the agricultural markets, the farmer would be benefitted in terms of selling its products.

In Chhattisgarh such study has been done for cereals and pulses, but not for oilseeds so it has been attempted to fill up this gap through this study. With the help of forecasting of

arrivals and prices, farmers of this State could find the forecast for the specific month in which they get high and remunerative price of their produce.

To get a good idea of the arrivals and prices of oilseeds varying over the time, it is necessary to study the time series patterns of arrivals and prices over the years in major markets of Chhattisgarh. Using the data collected in this study, different linear, non-linear and time series models are fitted for both variables in these markets, and best model based forecasts were made to fulfil the requirements of planners and farmers.

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Major Advisor

शोध सारांश

अ) शोध का शीर्षक	: छत्तीसगढ़ में तिलहन की आवक और कीमतों का पूर्वानुमान
ब) छात्र का पूरा नाम	: अंकुर कुमार राठौर
स) मुख्य विषय	: कृषि सांख्यिकी
द) प्रमुख मार्गदर्शक का नाम और पता	: डॉ. ए. के. सिंह, प्राध्यापक एवं विभागाध्यक्ष, कृषि सांख्यिकी एवं सामाजिक विज्ञान विभाग, कृषि महाविद्यालय, रायपुर (छ.ग.)
इ) उपाधि	: कृषि में स्नातकोत्तर (कृषि सांख्यिकी)

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छात्र का हस्ताक्षर

प्रमुख मार्गदर्शक के हस्ताक्षर

दिनांक: 21-07-2020

विभागाध्यक्ष के हस्ताक्षर

सारांश

तिलहनी फसलों की भारत की कृषि अर्थव्यवस्था में बहुत महत्वपूर्ण भूमिका हैं, जिसमें भारत के तिलहन फसलों के अंतर्गत विविध क्षेत्र हैं। छत्तीसगढ़ राज्य के विभिन्न भागों में मूंगफली, सूरजमुखी, तिल, सोयाबीन, अलसी, सरसों-रेपसीड सहित सात तिलहनी फसलें उगाई जाती हैं।

कृषि के विकास के लिए यह बहुत आवश्यक है कि किसानों को कृषि बाजारों में अपने उत्पादों की अच्छी कीमत मिले। यदि कृषि बाजारों में आवकों और कीमतों का कुछ पूर्वानुमान हो सके तो किसान को अपने उत्पादों को बेचने का लाभ हो सकेगा।

छत्तीसगढ़ में ऐसा अध्ययन अनाज और दालों के लिए किया गया है, लेकिन तिलहन के लिए नहीं, इसलिए इस अध्ययन के माध्यम से इस शून्यता को भरने का प्रयास किया गया है। आवकों और कीमतों के पूर्वानुमान की मदद से, इस राज्य के किसान उस विशिष्ट महीने के पूर्वानुमान का पता लगा सकते हैं जिसमें उन्हें अपनी उपज का उच्च पारिश्रमिक मूल्य मिल सकेगा।

परिवर्तनीय समय के ऊपर आवकों और कीमतों का एक अच्छा पूर्वानुमान प्राप्त करने के लिए यह आवश्यक है कि छत्तीसगढ़ के प्रमुख बाजारों में विभिन्न वर्षों के आवकों और कीमतों के समय-श्रृंखला रुझानों का अध्ययन किया जाए। इस अध्ययन से संग्रहित इन आंकड़ों का उपयोग करते हुए, इन बाजारों के दोनों चरों के लिए विभिन्न रैखिक, गैर-रैखिक और समय श्रृंखला मॉडल फिट किए गए और योजनाकारों और किसानों की आवश्यकताओं की पूर्ति हेतु सर्वश्रेष्ठ मॉडल आधारित पूर्वानुमान किये गये ।

डॉ. ए. के. सिंह
प्रमुख मार्गदर्शक

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CHAPTER – I
INTRODUCTION

Indian Agriculture is one of the most significant contributors to the Indian socio-economic sector. It is the major source of employment; employing almost 60% of the people of India. The agriculture sector of India occupies almost 43% of India's geographical area. It is still the only largest contributor to India's GDP (16%).

Chhattisgarh is a State which was formed in 2000 by carving out some eastern parts of erstwhile Madhya Pradesh. It is the 10^{th} largest state in India with a geographical area of 13,790 thousand hectare with net sown area 4677 thousand ha.

Nearly 80% population of the State of Chhattisgarh is dependent on agriculture. Out of 37.46 lakh farmers' households, 76% come under small and marginal category. At present, 35% of land in the state has irrigation facility from all the sources of irrigation, out of which maximum 52% of land is irrigated from reservoirs/canals, which is mostly dependent on rain. Around 55% arable land is having less water retention capacity due to which second crop is not possible without irrigation facility. At the time of formation of this State, there was lack of necessary agricultural infrastructure, viz., seed processing centre, farmer's training centre, fertilizer and godown, due to which productivity of various crops in the State was less than those of other developed states. After formation of the State, the pace of agricultural development speeded up due to higher priority accorded to the agricultural programmes by the state government.

Oilseed crop plays the significant role in improving and sustaining the health of the people and economy of the country. Oilseed improves the flavour, taste, quality, and palatability of food material. Oilseeds are rich source of carbohydrates, essential fatty acids and vitamins such as of types A,D,E and K. Oilseed crops forms an important component of crop diversification and plays significant role in the commercialization of agriculture.

Oilseed crops play a very important role in the agricultural economy of India which has the distinction of large area under oilseed crops. The diverse agro

ecological conditions in the country are favourable for growing nine types of oilseeds. Out of these, seven edible oilseeds include the crops groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower and niger seed while two non-edible oilseeds include the crops castor and linseed. Oilseeds occupy about 13% of gross cropped area and account for nearly 3% of gross national product (GNP) and 10% of the value of all agricultural commodities. About 14 million farmers are engaged in oilseed production and another 1 million in their processing. The edible oil industry is one of the most vibrant sectors of the Indian agricultural economy. In the State of Chhattisgarh, seven oilseed crops, both edible and non-edible, namely, groundnut, sunflower, niger, sesame, soybean, linseed, mustard-rapeseed are grown in its different parts. Soybean occupies first position both in area and production among oilseeds in Chhattisgarh.

Agricultural marketing comprises of all activities involved in the movement of agricultural products from the farms to the consumers. A sea-change has been taken place in agricultural marketing scenario in the country over the last six decades. A few parameters in the changed scenarios are pertinent to mention here. For example, i) there is a significant increase in the supply of agricultural commodities due to better agricultural technologies leading to market surpluses; ii) due to increase in urbanization and income levels there is change in the pattern of demand of farm products and their derivatives; iii) due to surge in communication channels there is now an increased level of linkages between domestic farm markets and the overseas markets; iv) there is now increased degree of government intervention policy wise in agricultural markets than ever before. Therefore, the framework under which agricultural product markets function and the factors which influence the prices received by the farmers need to be understood in a different perspective compared to that in the past.

In India, agricultural marketing is done through Agricultural Markets (*Mandis*) located in various small and large towns. There are nearly 1700 Agricultural Markets all over India. Presently, 69 agricultural markets (*Mandis*) and 118 sub agriculture markets (*Upmandis*) are working in Chhattisgarh. There is special contribution of these agriculture markets in better planning of agriculture production. Each of this market constitutes Agricultural Produce Marketing

Committee (APMC). The main objectives of these committees are i) ensuring transparency in pricing system and transactions taking place in market area, ii) providing market-led extension services to farmers, iii) ensuring payment for agricultural produce sold by farmers on the same day, iv) publicising data on arrivals and rates of agricultural produce brought into the market area for sale v) setup and promote public private partnership in the management of agricultural markets.

There is instability in the prices and income within agricultural sector. Present agriculture has become highly input and cost intensive. The past trend in production and market arrivals of commodities are useful in understanding the present situation and to forecast the future. Forecasting is the process of making predictions for future phenomenon based on past and present data. Forecasting gives useful input for proper planning in agricultural sector, in which uncertainties occurs. Forecasts of agricultural production and prices are intended to be useful for farmers, governments, and agribusiness industries. Because of the special position of food production in a nation's food security, government have become both principal suppliers and main users of agricultural forecasts. They need internal forecasts to execute policies that provide technical and market support for the agricultural sector. Government publications routinely provide private decision makers with commodity price and output forecasts at regional and national levels and at various horizons. For the development of agriculture, it is quite necessary that farmers get good prices of their products in the agricultural markets. If there could be some forecast of arrivals and prices in the agricultural markets, the farmer may be benefitted in terms of selling its products.

In Chhattisgarh, such studies were conducted for cereals and pulses, but not for oilseeds. Therefore, to fill this gap, it was necessary to undertake such study. With the help of forecasting of arrivals and prices, farmers of this State would find the forecast for the specific month in which they get high and remunerative price of his/her produce.

There are two basic approaches of forecasting. One approach which considers causes and their effects and the other approach which forecasts prices

without taking into consideration the causes. The time series approach depends on the past patterns in a time series to forecast prices in the future.

To get a good idea of the Arrivals and Prices of oilseeds have varied over the time, it is necessary to study the trends of Arrivals and Prices over the years. This study aims at collecting the data of arrivals and prices of 20 agricultural markets of Chhattisgarh for oilseeds, where data could be obtained. Using these data, different linear, non-linear and time series models have been fitted for Arrivals and Prices of oilseeds in markets of Chhattisgarh, and best model based forecast has been attempted to fulfil the requirements of planners and farmers. Thus, the present study aims to fulfil following objectives:

- To study the trend in arrivals and prices of oilseeds in Chhattisgarh.
- To study the seasonality pattern of oilseeds in arrivals and prices of oilseeds in Chhattisgarh.
- To identify the best forecasting model for arrivals and prices of oilseeds in Chhattisgarh.
- Forecasting of arrivals and prices of oilseeds in Chhattisgarh.

CHAPTER – II
REVIEW OF LITERATURE

Gupta (2018) attempted to study the trend and seasonality pattern of arrivals and prices of pulses in the markets (*mandis*) of Chhattisgarh and forecasted them using best selected models for January 2018 to December 2019. The ARIMA models of suitable orders were predominantly found to be the best fitted model based on multiple criteria of highest R^2, lowest RMSE, MAPE and MAE. The forecasted arrivals and prices of pigeonpea, chickpea, blackgram/greengram, lathyrus, pea and lentil for these models were found to be very close to the actual arrivals and prices.

Sahu (2018) made an attempt to analyze trends in arrivals and prices of paddy in Agricultural Market Committees of Chhattisgarh State and concluded that the Trend and Seasonality Pattern in arrivals and prices of paddy are not found to be same in all markets. The coefficient of correlation was computed to find the pattern of association between market arrivals and prices of paddy. Significant positive correlations were obtained for the markets of Chhattisgarh Total, Chhattisgarh Plains, Northern Hills Region, Bastar Plateau and Kanker, whereas for Kurud, Navapara, Ambikapur and Jagdalpur markets non-significant correlations were observed.

Meena and Sharma (2016) analyzed trend and seasonality of wheat in select market of Sriganaganagar district. They observed that the prices of wheat showed a positive trend in all the markets. The results show that the highest seasonal indices of prices were observed in the month of November to May whereas the lowest seasonal indices were observed from March to June in all the markets.

Naidu and Srikala (2016) have used time series analysis such as trend analysis, seasonal variations and cyclic variations of arrivals and prices of maize in Jammikunta and Warangal markets of Andhra Pradesh. The study

revealed that seasonal variations of arrivals and prices were non-significant during the period of study in select markets.

Kumar and Gowda (2015) forecasted the price of maize in selected market of Karnataka. They collected monthly time series data for 16 years from 1999 to 2014 from APMC's of Davangere. To assess the best forecasting model different methods were carried out during the study period and Double exponential smoothing method was found to give the best fitted forecasting price of maize in Davanagere market by considering all the parameters.

Rao et al. (2014) forecasted the wholesale price of rice. They selected ARIMA (2,2,0) and ARIMA (0,1,1) models to forecast the wholesale prices of rice in Andhra Pradesh and Guntur district of Andhra Pradesh respectively on the basis of the Schwartz Bayesian Criterion (SBC) and Akaike Information Criterion (AIC). The forecasting of wholesale prices of rice were found to be fairly accurate and showed increasing trends in both Andhra Pradesh and its Guntur district.

Keerthi and Naidu (2013) studied the forecast in Madanapalli market of Chittoor district about monthly prices of tomato by fitting ARIMA models. They concluded that ARIMA (2,0,2) (1,0,1) model was suitable to produce price forecasts of tomato for next years.

Naidu and Kumari (2013) revealed that the highest arrivals of castor observed were in the month of October and December for Kurnool market, in September to October for Adoni market. There existed increasing trend of arrivals and prices with some variation from market to market and a positive correlation was found between arrivals and prices over the years and across months in both the markets.

Chandrakala (2009) forecasted the arrivals and prices of groundnut in Chitradurga, Challakere, Yadagir, Bellary and Davangere markets of Karnataka using ARIMA model. The best forecast was experienced by Bellary market among the five markets.

Asmatoddin et al. (2009) calculated seasonal indices for important oilseed crops in Pharbhani market for arrivals and prices for the time period from 1996-97 to 2004-05. They found that the total arrivals of soybean crop occurred more than 90 percent during October and December months. The price index was found to be highest in the month of July (115.46 per cent).

Reddy (2008) attempted to forecast the prices of soybean and soya oil in major oilseed markets of India by using ARIMA model. He found that there is wide variation between actual and predicted prices soya oil and there was narrow variation between actual and predicted prices of soybean.

Punitha (2007) attempted to study the trend, seasonal indices and seasonality pattern of arrivals and prices of groundnut and maize in Hubli and Davangere market. For maize, increasing trend is seen in in arrivals Davangere market but Hubli market have constant trend and in both the markets an increasing trend is seen in prices. In Hubli market negative and non-significant relationship between arrivals and prices was observed for maize. On the other hand, in Davangere market positive and significant relationship was observed.

Iqbal et al. (2005) attempted to forecast the area and production of wheat in Pakistan up to the year 2022. 20 year ahead forecasts was done by ARIMA(1,1,1) and ARIMA(2,1,2). The ARIMA model show that area of wheat were 8475.1 thousand hectare and the production 29774.8 thousand tonnes in the year 2022.

Sangeeta Shroff (2004) analyzed the arrivals and prices of onion in Pune and Lasalgaon markets of Maharashtra from 1999-2002. She observed in Pune market that the arrivals of onion were more in January and February in Lasalgaon market but the arrivals began increasing in February and March. An upward trend was observed from the month of June to November after which it started declining.

Wadhwani and Bhogal (2003) studied the price behaviour of cauliflower and cabbage in Western Uttar Pradesh (1988-1997) and concluded that the prices of

these two vegetables were maximum in the month of September and minimum in March. The prices started increasing from the month of May and then declined from October onwards.

Nahatkar et al. (1998) found that seasonal index of cotton prices was maximum in the third quarter (April to June) and minimum in the second quarter (January to March) of the year. The price rise was higher during first quarter (October to December) as shown by the coefficient of variation for prices. This is due to the buyers attract more cotton growers to sell their produce at lower prices. The variation in prices of cotton was found to be less than that of variations in arrivals.

Prakash and Srivastava (1994) conducted their study on pattern of market arrivals and prices of gram in Uttar Pradesh and reported that the inter year variation in market arrivals of gram in terms of average annual arrivals varied between 86.6 and 120.0 per cent from 1987 to 1992. The variation in market arrivals were not directly related with the annual production of gram in the state. The lowest market arrival of gram was recorded during 1988-89 in spite of maximum production of gram in the state during that year.

Mundinamani et al. (1991) estimated trend, seasonal indices and co-efficient of variation in arrivals and prices using monthly time series data on market arrivals and prices of groundnut for Gadag and Hubli markets during 1960-61 to 1983-84. The market arrivals pattern of groundnut indicated a seasonal character. In a short run, the prices of groundnut were found to be the function of market arrivals only. He eliminated the seasonal pattern of market arrivals and there resulting short run instability in groundnut prices. 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 steady rise in demand for the groundnut products.

Devaiah et al. (1988) forecasted the prices of Cocoons at Ramanagaram market by using ARIMA model. The forecasting was done for 13 months from April 1987 to

April 1988. It is concluded that the forecasted values were close to the actual prices.

Govindan (1974) analyzed wholesale price indices of rice, wheat, jowar and gram using Box and Jenkins (1976) model. The short term forecasts were found to have good results but the same was not true for long term forecasts.

CHAPTER – III
MATERIALS AND METHODS

This chapter deals with the materials and methods employed for selection of the markets, sources of the data and the conceptual methodologies used their analyses. The methodology adopted for the study is described according to the objectives of the study as already stated in the Introduction (See Chapter I), as following:

3.1 Selection of Markets

Out of 69 agricultural markets (*mandis*) in Chhattisgarh, major oilseed arrivals take place predominantly in 20 agricultural markets only. These 20 markets are considered as sampled population whose data are available in the website where from the data has been collected. Usually, the distribution of arrivals of oilseed crops in different markets are as following:-

S.N.	Mandis	Oilseed crops
1.	Kawardha	Soybean
2.	Bemetara	Soybean
3.	Bhatapara	Soybean, Mustard
4.	Basna	Groundnut
5.	Rajnandgaon	Soybean, Linseed, Mustard
6.	Khairagarh	Soybean
7.	Gandai	Soybean
8.	Dongargaon	Soybean
9.	Raipur	Mustard
10.	Champa	Groundnut, Mustard
11.	Pendra Road	Mustard
12.	Mungeli	Soybean
13.	Gharghoda	Groundnut

14.	Raigarh	Groundnut
15.	Baikunthpur	Mustard
15.	Patthalgaon	Groundnut, Mustard
17.	Jashpurnagar	Groundnut, Mustard, Sesame
18.	Ramanujganj	Groundnut, Sesame, Linseed
19.	Ambikapur	Groundnut, Sesame
20.	Pratappur	Groundnut

3.2 Selection of Crops

The oilseeds crops which were brought in *mandis* of Chhattisgarh during 2010-2019, namely soybean, groundnut, sesame, linseed, sunflower and mustard, and which have been published in the website have been selected for the study.

3.3 Collection of Data

The time series data on the monthly arrivals and prices of oilseeds have been collected from the records of the Agricultural Products Market Committees and the website of Chhattisgarh State Agricultural Marketing (*Mandi*) Board, http://agriportal.cg.nic.in/agrimandi/ or http://cg.nic.in/agrimandi/. The data on monthly arrivals and prices in Chhattisgarh were available in the above stated website(s) from 2010 only. So, the data have been collected for the study period, i.e. 2010 to 2019 (10-years).

3.4 Software Used

In the present study, Statistical analyses have been carried out using the powerful software "R: The Project for Statistical Computing" which is also being used currently at various Universities, not only in Statistical Departments but also in many other applied branches of science.

R is an environment and language for graphics and statistical computing developed by Ross Ihaka and Robert Gentleman, which is a GNU project similar to the S language which was developed by John Chambers and colleagues at Bell Laboratories (formerly AT&T, now Lucent Technologies).

R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form. It compiles and runs on a wide variety of operating system platforms such as Windows, MacOS and UNIX platforms and similar systems (including FreeBSD and Linux).

R is an integrated suite of software facilities for data manipulation, calculation and graphical display. It includes

- an effective data handling and storage facility,
- a suite of operators for calculations on arrays, in particular matrices,
- a large, coherent, integrated collection of intermediate tools for data analysis,
- graphical facilities for data analysis and display either on-screen or on hardcopy, and
- a well-developed, simple and effective programming language which includes conditionals, loops, user-defined recursive functions and input and output facilities.

Many of users think R as a statistical system. However, we prefer to think of it as an environment within which statistical techniques are implemented. Anybody can extend R easily via *packages*.

3.5 Time Series Analysis

Time series data

A time series is simply a series of data points ordered in time. In a time series, time is often the independent variable and the goal is usually to make a forecast for the future.

Time Series Components

Time series data have four components viz. trend, seasonality, cyclic fluctuation and random component.

Trend component (T_t): Trend of time series means the regular, smooth, long-term movement of a series if observed long enough. The series may exhibit an upward or a downward trend or may remain more or less at a constant level.

Cyclical component (C_t): Cyclical fluctuations mean the oscillatory movement in a time series or the period of oscillation being more than a year. One complete period is called a cycle. The cyclical fluctuations are not necessarily periodic, since the length of the cycle as also the intensity of fluctuations may change from one cycle to another.

Seasonal component (S_t): Seasonal fluctuations mean a periodic movement in a time series where the period is less than a year. A periodic movement in a time series is one which recurs, or say, repeats at regular intervals of time (or periods). Examples of seasonal fluctuations may be found in the passenger traffic during the 24 hours of a day, sales of departmental stores during the 12 months of a year, issue of library books during the seven days of a week, and so on. The factors which mainly cause this type of variation in time series are due to climatic changes of the different seasons and the customs and habits which the people follow at different times. E.g., the occurrence of a festival in a particular month will increase the sale of certain consumer goods in that month.

Irregular component (I_t): Irregular fluctuations are those which are either wholly unaccountable or are caused by such unforeseen events as wars, floods, strikes, etc. This category of movement includes all types of variations that are not accounted for by secular trend, seasonal or cyclical fluctuations.

3.5.1 Time Series Model

For analysis of time series data there are two models. One is a multiplicative model and another is an additive model.

Let the observation at a point of time, t (for t = 1, 2, 3…), be denoted by Y_t and its four components viz., Trend, seasonal, Cyclical Variations, Irregular

denoted by T_t, S_t, C_t and I_t respectively, then this observation can be represented by the following two types of linear models, namely, additive and multiplicative:

1. Additive: $Y_t = T_t + S_t + C_t + I_t$
2. Multiplicative: $Y_t = T_t \times S_t \times C_t \times I_t$

How to Select Between two models (additive/multiplicative):

1. The additive model is appropriate where seasonal fluctuations are relatively constant in size over time and not seem to depend on the level of the time series and the random fluctuations are also constant in size over time.
2. The multiplicative model is appropriate where seasonal fluctuations are not constant in size over time and seem to depend on the level of the time series and the random fluctuations are also not constant in size over time.
3. It may be noted that, only one model, either additive or multiplicative, for a time series model of a given variable (Y_t) should be considered. For this we may draw a time series graph of the given variable and see if the amplitude of the graph over different years increases with years, in which case the model should be considered as multiplicative, otherwise additive.

3.5.1.1 Analysis of Trend of Arrivals and Prices

Moving Average method has been used to know the overall trend of arrivals and prices of oilseeds in Chhattisgarh for the entire study period. The moving average measures the trend by smoothing out the fluctuations of the data by means of obtaining successive averages over successive sub-periods moving ahead at successively.

The seasonal and irregular components are eliminated by the standard moving average method. In R, *decompose()* function has been applied for getting the moving average trend values as *decompose(time.series.data)$trend*. The time series data of arrivals and prices have been plotted in the graph using *plot()* function as *plot(time.series.data*) and by using *lines()* function the line of trend have been plotted in the same graph as *lines(time,trend.values).* This moving average trend values have been refined to a straight line trend for a general interpretation of increase or decrease over a long period of time. For this, a straight

line regression equation has been fitted to the moving average trend values obtained as above, i.e. *decompose(time.series.data)$trend*. Thus

$$y = a + bt \qquad \text{----------(3.1)}$$

where, y is moving average trend values; t is corresponding time point over the study period; a and b are the coefficients for fitting above regression line (3.1). In R, the fitted values have been obtained by using *lm()* function as *lm(time.series.data ~time)* and further got a straight line of regression over the moving average trend line by using *abline()* function as *abline(fitted.values).*

3.5.1.2 Analysis of Seasonality Pattern of Arrivals and Prices

To measure the seasonal variation in monthly time series data of arrivals and prices, seasonal indices have been calculated by Method of Simple Averages to find the seasonal effect, as given below:

The method of simple averages uses to find the monthly seasonal index involving following steps:

I. Arrange the data by months over different years.

II. Compute the monthly averages $\bar{X}_i$ for i^{th} month for all the years. (i^{th} month, i=1,2,……12 represents Jan, Feb,……Dec respectively).

III. Compute the average of monthly averages, i.e., $\bar{\bar{X}} = \frac{1}{12}\sum_{i=1}^{12} \bar{X}_i$

III. Seasonal indices for different months are obtained by expressing monthly averages as percentage of $\bar{\bar{X}}$.

Thus, seasonal index for *i*th month is given by, $\frac{\bar{X}_i}{\bar{\bar{X}}} \times 100$.

Using R, *barplot()* function has been used to draw a graph of seasonal index as obtained by Method of Simple Averages. *decompose()* function has been applied for getting the seasonal component values as *decompose(time.series.data)$seasonal*. The time series data of arrivals and prices have been plotted in the graph using *plot()* function as *plot(time.series.data*) and by using *lines()* function the seasonal variation have been plotted in the same graph as *lines(time,seasonal.component.values).*

3.6 Time Series Forecasting Models for Arrivals and Prices

Various time series forecasting models have been fitted to the arrivals and prices of the oilseed crops for the *mandis* of Chhattisgarh, namely, polynomial models of suitable degree in time variable. Additionally, some non-linear models emanating from such transformation as Compound function, Inverse function, Logarithmic function, Power function, Exponential function, growth function, S-curve function, Exponential smoothing, apart from Holt-Winters, Autoregressive Integrated Moving Average (ARIMA) models have also been fitted. In fact, the three models, namely, Exponential, Holt-Winters and ARIMA models, are now a days fitted to the time series models in general, the models mentioned above earlier to these three have been in use traditionally since long (vide references Goon, A.M., Gupta, M.K. and Gupta, B.D. 1979. Fundamentals of Statistics. Vol.II, 5th Revised Edition, The World Press Private LTD, Calcutta, : 313-314; Gupta, A.K. 2018. Forecasting of Arrivals and Prices of Pulses in Chhattisgarh – A Statistical Approach. M.Sc.(Agri) Thesis, I.G.K.V. Raipur, : 13-24 and Gupta, S.C. and Kapoor, V.K. 2007. Fundamentals of Applied Statistics. Sultan Chand & Sons, New Delhi, : 2.9-2.11.). Therefore, in this thesis an attempt is being made to compare the model fittings of these traditional models with the later three models. All the above-cited models were fitted using various functions available in the R software packages as indicated in Section 3.4, like *lm()* function in the 'base' package, *HoltWinters()* in the 'stats' package, *arima()* in 'stats' package and 'forecast' package. Thus, the models fitted are as follows:

3.6.1. Polynomial model

In polynomial model the mathematical equation is given as

$$Y_t = \alpha + \beta_1 t + \beta_2 t^2 + ... + \beta_i t^i + ... + \beta_n t^n$$

where,

'Y_t' is the dependent variable, that is, Arrivals or Prices of the Oilseed Crops in *Mandis* of Chhattisgarh

where,

't' is the independent variable, time in taken in months

'α' is the intercept of the polynomial model

'β_i' is the regression coefficients for the i^{th} term of the polynomial model
'n' is the degree of polynomial

The estimation of α and β is done by using the ordinary least squares approach.

In R, first order polynomial model has been fitted by using command *lm(time.series.data~Time)*.
For the second order polynomial model, the command used is *lm(time.series.data~Time+I(Time^ 2))*.
For the third order polynomial model, the command used is *lm(time.series.data~Time+I(Time^ 2)+I(Time^3))* and so on.

3.6.2. Compound function non-linear model

When it is known that there is increasing growth or decline in past periods this function is useful.
Compound function is given as

$$Y_t = \alpha \beta^t$$

where,
'Y_t' is the dependent variable, that is, Arrivals or Prices of the Oilseed Crops in *Mandis* of Chhattisgarh
't' is the independent variable, time in taken in months
'α' is the intercept of Compound function non-linear model
'β' is coefficient of regression

The estimation of α and β is done by using the ordinary least squares approach after logarithmic transformation.

In R, compound function non linear model has been fitted by using command *lm(log(time.series.data)~Time)*.

3.6.3. Inverse function non-linear model

Inverse function is given by the equation

$$Y_t = \alpha + \beta /t$$

where,

'Y_t' is the dependent variable i.e., Arrivals or Prices of the Oilseed Crops in *Mandis* of Chhattisgarh

't' is the independent variable, time in months

'α' is the intercept of inverse function non-linear model

'β' is the coefficient of regression

The estimation of α and β is done by using the ordinary least squares approach after proper transformation.

In R, inverse function non linear model has been fitted by using command *lm(time.series.data~Time^(-1))*.

3.6.4. Logarithmic function non-linear model

The mathematical equation of logarithmic function is given as

$$Y_t = \alpha + \beta \ln (t)$$

where,

'Y_t' is the dependent variable i.e., Arrivals or Prices of the Oilseed Crops in *Mandis* of Chhattisgarh

't' is the independent variable, time in months

'α' is the intercept of logarithmic non-linear model

'β' is the coefficient of regression.

The estimation of α and β is done by using the ordinary least squares approach.

In R, log function non linear model has been fitted by using command *lm(time.series.data~log(Time))*.

3.6.5. Power function non-linear model

The mathematical model of power function is

$$Y_t = t^{\beta}$$

where,

'Y_t' is the dependent variable i.e., Arrivals or Prices of the Oilseed Crops in *Mandis* of Chhattisgarh

't' is the independent variable, time in months

'β' is the coefficient of regression

The estimation of α and β is done by using the ordinary least squares approach after proper transformation.

The fit is similar to exponential fit, but makes a forecast curve that increase or decreases at different rate.

In R, power function non linear model has been fitted by using command *lm(log(time.series.data)~log(Time)).*

3.6.6. Exponential function non-linear model

The mathematical equation of exponential function can be given as

$$Y_t = \alpha e^{\beta t}$$

where,

'Y_t' is the dependent variable i.e., Arrivals or Prices of the Oilseed Crops in *Mandis* of Chhattisgarh

't' is the independent variable, time in months

'α' is the intercept of Exponential function non-linear model

'β' is the coefficient of regression

The estimation of α and β is done by using the ordinary least squares approach after proper transformation.

In R, exponential function non linear model has been fitted by using command *lm(log(time.series.data)~Time).*

3.6.7. Growth function non-linear model

This Growth function is given as

$$Y_t = \text{Exp}\ (\alpha + \beta t)$$

where,

'Y_t' is the dependent variable i.e., Arrivals or Prices of the Oilseed Crops in *Mandis* of Chhattisgarh

't' is the independent variable, time in months

'α' is the intercept of Growth function non-linear model

'β' is the regression coefficients

The estimation of α and β is done by using the ordinary least squares approach after proper transformation.

In R, growth function non linear model has been fitted by using command *lm(log(time.series.data)~Time).*

3.6.8. S-curve non-linear model

S- Curve fit is given as

$$Y_t = \text{Exp}\ (\alpha + \beta/t)$$

where,

'Y_t' is the dependent variable i.e., Arrivals or Prices of the Oilseed Crops in *Mandis* of Chhattisgarh

't' is the independent variable, time in months

'α' is the intercept of S-curve non-linear model

'β' is the regression coefficients

The estimation of α and β is done by using the ordinary least squares approach after proper transformation.

In R, S-curve function non linear model has been fitted by using command *lm(log(time.series.data)~Time^(-1)).*

3.6.9. Exponential Smoothing

For the time series data $Y_1, Y_2 \ldots\ldots Y_{t,}$ the exponential smoothing forecast is given by F_{t+1} as follows:

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

where,

F_t is the most recent forecast at time t.

α is weight for the most recent observation $Y_{t,}$ known as smoothing constant.

(1-α) is the weight for the most recent forecast F_t.

In R, S-curve function non linear model has been fitted by using command *HoltWinters(time.series.data, beta=FALSE, gamma=FALSE).*

3.6.10. ARIMA Model

In statistics and econometrics, and in particular in time series analysis, an autoregressive integrated moving average (ARIMA) is a generalization of an autoregressive moving average (ARMA). The autoregressive (AR) part of the ARIMA model indicates a type of random process representing certain time-varying processes in nature, economics, etc., while the moving average (MA) part is the average attained over a particular period of cycle.

It indicates that the output variable depends linearly on its own previous values and on a stochastic term. This AR(p), an autoregressive model of order p, can be defined as,

$$Y_t = \mu + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \varepsilon_t \qquad \text{----------(3.2)}$$

where $\Phi_1, \ldots . \Phi_p$ are the parameters of the model, μ is a constant, and ε_t is white noise

The second component of ARIMA is Moving-Average (MA) model. The general MA process of order q can be defined as,

$$Y_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} \qquad \text{----------(3.3)}$$

where μ is the mean of series, the $\theta_1 \ldots \theta_q$ are the parameters of the model and the $\varepsilon_t, \varepsilon_{t-1}, \ldots, \varepsilon_{t-q}$ are the noise error terms. The value of q is called the order of the MA model.

Now, combining the AR process with the MA process and integrating, with differencing step, to remove non-stationarity from the non-seasonal time series, the ARIMA is generally denoted by ARIMA(p,d,q), where parameters p, d, and q are non-negative integers, where p is the order of the autoregressive model, d is the degree of differencing, and q is the order of the moving-average model. In other words, ARIMA(p,d,q), is an autoregressive integrated moving average time series, where p denotes the number of autoregressive terms, d the number of times the series has to be differenced before it becomes stationary, and q the number of moving average terms.

Thus, the ARIMA(p,d,q) model can be represented by the following general forecasting equation:

$$Y_t = \mu + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} + \varepsilon_t \qquad \text{----------(3.4)}$$

Or,

$$\widehat{Y_t} = \mu + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} \qquad \text{----------(3.5)}$$

In R, best ARIMA model has been fitted by using command *auto.arima(time.series.data).*

3.7 Selection of Time Series Model

For Arrivals and Prices of oilseeds in different markets the best model will be that which have maximum R^2, minimum Mean Absolute Percentage Error (MAPE), minimum Mean Absolute Error (MAE), and minimum Root Mean Square Error (RMSE) criterion. Best time series models can be identified after analysis for each market; by which the Arrivals and Prices of oilseeds in the selected markets of Chhattisgarh can be forecasted.

3.7.1 Coefficient of Determination (R^2 criteria)

R^2 is a statistical measure that gives information about overall variation explained by the given model out of total variation. In R, *summary(model)$r.squared* command is used to get R^2 value. Mathematically is expressed as:

$$R^2 = 1 - \frac{\text{SSres}}{SS_{total}} \quad \text{---------- (3.6)}$$

where, SS_{res} = residual sum of squares and SS_{total} = total sum of squares. In general, the higher the R^2 value obtained for a model, the better the model fit is said to be.

3.7.2 Root Mean Square Error (RMSE)

It is the standard error of the residuals (prediction errors). The RMSE tells you how concentrated the data is around the line of best fit. It has also been used for model selection. The lesser value of RMSE the better is model fit. In R, *sigma(model)* function is used to get RMSE value, and it is mathematically expressed as:

$$\text{RMSE} = \sqrt{\frac{\sum e_i^2}{df}} \quad \text{----------(3.7)}$$

where, $e_i = y_i - \hat{y}$, y_{i} denote the i$^{\text{th}}$ observation and $\hat{y}$ denote a forecast of y_{i}, and df is the degrees of freedom corresponding to the error.

3.7.3 Mean Absolute Error (MAE)

It measures the average magnitude of the errors in a set of predictions, i.e., without considering their direction. Thus, it is the average over the test sample of the absolute differences between predicted ($\hat{y}$) and actual observations (y_i) with all individual differences having equal weights. The lesser value of MAE, the better is the model. In R, *mean(abs(residuals(model)))* command is used to get MAE. It is mathematically expressed as:

$$\text{MAE} = \overline{|e_\iota|} \quad \text{----------(3.8)}$$

where, $e_i = y_i - \hat{y}$, y_{i} denote the i$^{\text{th}}$ observation and $\hat{y}$ denote a forecast of y_{i}.

3.7.4 Mean Absolute Percentage Error (MAPE)

It is a measure of accuracy of a forecasting method in statistics. It expresses the mean of the percentage errors over different points of time. The lesser value of MAPE, the better is the model. In R, *100*mean(abs((time.series.data-fitted.value)/time.series.data))* command is used to get MAPE. It is mathematically expressed as:

$$\text{MAPE} = 100 \times \overline{\left(\left|\frac{e_i}{y_i}\right|\right)} \qquad \text{----------(3.9)}$$

where, $e_i = y_i - \hat{y}$, y_i denote the i[th] observation and $\hat{y}$ denote a forecast of y_i. However, a little modification to the Equation (3.9) is hereby suggested whereby all values of y_i=0 are replaced with a very low value y_i=0.05, to save the Equation (3.9) taking infinite value, due to which entire value of MAPE is forced to become infinite. With this suggested modification, such situation could be avoided.

CHAPTER – IV
RESULTS AND DISCUSSION

This chapter presents the results obtained from the study. Keeping in view the objectives of the study, the data collected on the arrivals and prices of oilseed crops have been subjected to various statistical methods as outlined in Materials and Methods (see Chapter III). The results and discussion of the study have been divided into following sections for 20 agricultural markets where major oilseed arrivals took place.

4.1 Results for Arrivals and Prices of Oilseeds in Kawardha Market

4.2 Results for Arrivals and Prices of Oilseeds in Bemetara Market

4.3 Results for Arrivals and Prices of Oilseeds in Bhatapara Market

4.4 Results for Arrivals and Prices of Oilseeds in Basna Market

4.5 Results for Arrivals and Prices of Oilseeds in Rajnandgaon Market

4.6 Results for Arrivals and Prices of Oilseeds in Khairagarh Market

4.7 Results for Arrivals and Prices of Oilseeds in Gandai Market

4.8 Results for Arrivals and Prices of Oilseeds in Dongargaon Market

4.9 Results for Arrivals and Prices of Oilseeds in Raipur Market

4.10 Results for Arrivals and Prices of Oilseeds in Champa Market

4.11 Results for Arrivals and Prices of Oilseeds in Pendraroad Market

4.12 Results for Arrivals and Prices of Oilseeds in Mungeli Market

4.13 Results for Arrivals and Prices of Oilseeds in Gharghoda Market

4.14 Results for Arrivals and Prices of Oilseeds in Raigarh Market

4.15 Results for Arrivals and Prices of Oilseeds in Baikunthpur Market

4.16 Results for Arrivals and Prices of Oilseeds in Patthalgaon Market

4.17 Results for Arrivals and Prices of Oilseeds in Jashpurnagar Market

4.18 Results for Arrivals and Prices of Oilseeds in Ramanujganj Market

4.19 Results for Arrivals and Prices of Oilseeds in Ambikapur Market

4.20 Results for Arrivals and Prices of Oilseeds in Prartappur Market

4.1 Results for Arrivals and Prices of Oilseeds in Kawardha Market

4.1.1 Soybean

4.1.1.1 Trend in Arrivals and Prices of Soybean in Kawardha Market

Time series data for arrivals of soybean in Kawardha has been presented in Fig. 4.1: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 124749.5 quintals in November 2013 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of soybean have also been plotted over the observed time series.

The linearized trend in the arrivals of soybean in Kawardha has been indicated by dark-green line in the graph shown in Fig. 4.1: (e). It could be seen that the arrivals of soybean in Kawardha had shown a decreasing trend over the years.

Similarly time series data for prices of soybean in Kawardha has been presented in Fig. 4.1: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs.4269.67 in August 2012 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case also additive model was found to be appropriate to describe this time series for the same reason as given above for arrivals. The fitted values of prices of soybean have also been plotted.

The linearized trend in the prices of soybean in Kawardha has been indicated by dark-green line in the graph shown in Fig. 4.1: (f). It could be seen that the prices of soybean in Kawardha had shown an increasing trend over the years.

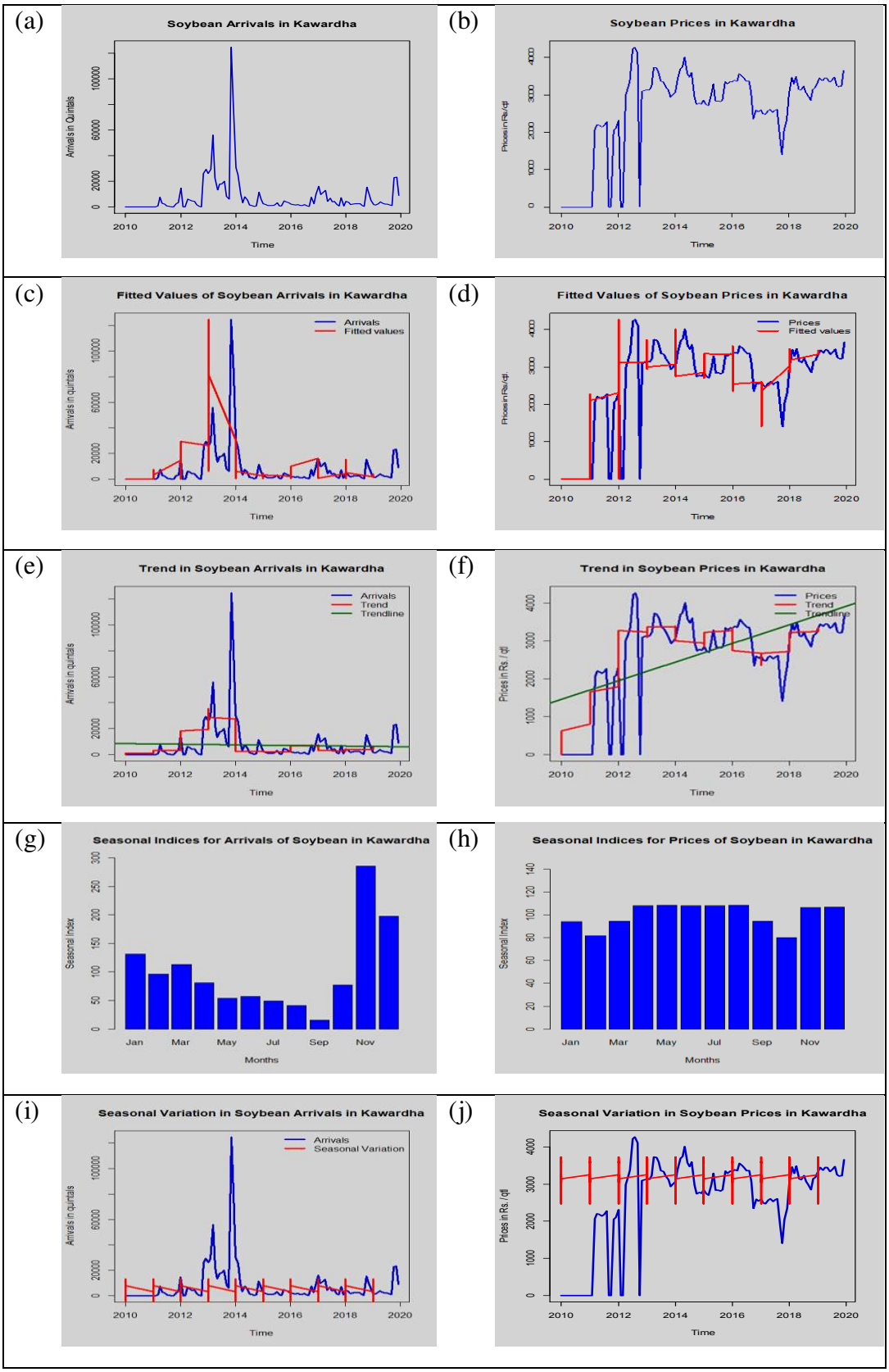

Fig. 4.1: Trend and Seasonality pattern in Arrivals and Prices of Soybean in Kawardha Market

4.1.1.2 Seasonality pattern in Arrivals and Prices of Soybean in Kawardha Market

The patterns of variation in arrivals within a year is revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.1: (g). The seasonal variation has been plotted in the graph of soybean arrivals in Kawardha.

Similarly, the patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.1: (h). The seasonal variation has been plotted in the graph of soybean prices in Kawardha.

4.1.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Soybean in Kawardha Market

By fitting different linear and non-linear time series models, we got following results for arrivals of soybean in Kawardha market presented in the Table 4.1.

Table 4.1: Parameters of Fitted Model of Arrivals of Soybean in Kawardha Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-Value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	465 433.3^{NS}	-227.4^{NS}	-	-	R^2= 0.001^{NS}	P= 0.645	15527.3	8273.9	15527.3
	2nd order	-1.86 x 10^9	1.84 x 10^{6*}	-4.58 x 10^{2*}	-	R^2= $0.048^{\$}$	P= 0.054	15223.5	7950.4	14579.9
	3rd order	-36 64.19^{NS}	159 50.8^{***}	-39 87.1^{***}	26 1.4^{***}	R^2= 0.137^{***}	P= 0.000	14557.7	7932.5	20273.6
2.	Linearized Compound	0^{***}	1.87^{***}	-	-	R^2= 0.270^{***}	P< 0.000	17074.7	7643.3	26621.0
3.	Linearized Inverse	-447 679.7^{NS}	9167 66720^{NS}	-	-	R^2= 0.001^{NS}	P= 0.648	15527.4	8273.9	26336.3
4.	Linearized Logarithmic	3480 950^{NS}	-456 557.3^{NS}	-	-	R^2= 0.001^{NS}	P= 0.646	15527.4	8273.9	26344.9
5.	Linearized Power	-	126 6.41^{***}	-	-	R^2= 0.271^{***}	P< 0.000	17074.5	7643.4	26570.0
6.	Linearized Exponential	0^{***}	0.62^{***}	-	-	R^2= 0.270^{***}	P< 0.000	17074.7	7643.3	26621.0
7.	Linearized Growth	-125 8.95^{***}	0.62^{***}	-	-	R^2= 0.270^{***}	P< 0.000	17074.7	7643.3	26621.0
8.	Linearized S-curve	127 3.8^{***}	-255 2656^{***}	-	-	R^2= 0.271^{***}	P< 0.000	17074.3	7643.5	26519.0
9.	Exponential Smoothing	0.51	-	-	-	χ^2= 31.67	P= 0.034	13596.3	5482.7	26334.7

10.	ARIMA (1,0,0) (0,0,1) [12]	-	-	-	-	χ^2= 3.10	P< 0.000 AIC= 2608.7	12254.3	5215.3	10651.7

Note: - Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.1, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(0,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2608.7) as indicated above, apart from lowest error measures like RMSE (12254.3), MAE (5215.3) and MAPE (10651.7). Thus, ARIMA model is chosen as best model for forecasting of soybean arrivals in Kawardha market.

Similarly, by fitting different linear and non-linear time series models as indicated above in Table 4.1, following results for prices of soybean in Kawardha market were obtained as presented in the Table 4.2.

Table 4.2: Parameters of Fitted Model of Prices of Soybean in Kawardha Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-Value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	4953 58.8^{NS}	24 7.2^{NS}	-	-	R^2= 0.342^{***}	P< 0.000	991.3	803.0	50110.6
	2nd order	-3.07 $x10^{8NS}$	3.05 $x10^{5*}$	-7.5^{*}	-	R^2= 0.548^{***}	P< 0.000	825.4	644.9	30695.4
	3rd order	-10 9.8^{NS}	212 4.1^{***}	-42 5.9^{***}	2 5.9^{***}	R^2= 0.689^{***}	P< 0.000	687.1	443.3	26181.1
2.	Linearized Compound	0^{***}	1.9^{***}	-	-	R^2= 0.365^{***}	P< 0.000	4541.1	3168.7	20333.0
3.	Linearized Inverse	5.01 $x10^{5\,NS}$	-1x $10^{9\,NS}$	-	-	R^2= 0.343^{***}	P< 0.000	990.8	802.6	50048.9
4.	Linearized Logarithmic	-378 7532^{NS}	4981 64.2^{NS}	-	-	R^2= 0.343^{***}	P< 0.000	991.1	802.8	50079.8
5.	Linearized Power	-	134 9.8^{***}	-	-	R^2= 0.366^{***}	P< 0.000	4531.6	3168.3	20294.0
6.	Linearized Exponential	0^{***}	0.6^{***}	-	-	R^2= 0.366^{***}	P< 0.000	4541.1	3168.7	20333.0
7.	Linearized Growth	-134 2.5^{***}	0.6^{***}	-	-	R^2= 0.366^{***}	P< 0.000	4541.1	3168.7	20333.0

8.	Linearized S-curve	135 7.1***	-2720 588***	-	-	R^2= 0.366***	P< 0.000	4538.0	3167.9	20256.0
9.	Exponential Smoothing	0.60	-	-	-	χ^2= 56.74	P< 0.000	689.5	352.8	17080.4
10.	ARIMA (1,0,0) (0,0,1) [12]	-	-	-	-	χ^2= 0.02	P< 0.000 AIC= 1887.7	646.4	359.8	14809.9

Note: - Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.2, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(0,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) and with (AIC=1887.7), as indicated above, among various models fitted apart from lowest error measures like RMSE (646.4), MAE (359.8) and MAPE (14809.9). Thus, ARIMA model is chosen as best model for forecasting of soybean prices in Kawardha market.

4.1.1.4 Forecasting of Arrivals and Prices of Soybean in Kawardha Market

After identification of the model, forecasting of arrivals and prices of soybean has been done. The best ARIMA model has been used to forecast the arrivals and prices of soybean in Kawardha market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.3 and also depitcted in graph in Fig 4.2.

Table 4.3 Forecasted values of Arrivals and Prices of Soybean in Kawardha Market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	7307.86	7418.86	3557.91	3494.74
February	6777.60	7332.82	3520.29	3487.95
March	6851.59	7283.33	3483.34	3481.28
April	7032.12	7254.85	3483.53	3481.31
May	6582.04	7238.46	3479.71	3480.63
June	6450.29	7229.04	3457.61	3476.64
July	6397.70	7223.61	3464.08	3477.81
August	6301.81	7220.49	3481.11	3480.88
September	6194.70	7218.70	3439.70	3473.41
October	9899.70	7217.66	3432.76	3472.16
November	10286.94	7217.07	3435.18	3472.59
December	7568.39	7216.73	3512.00	3486.45

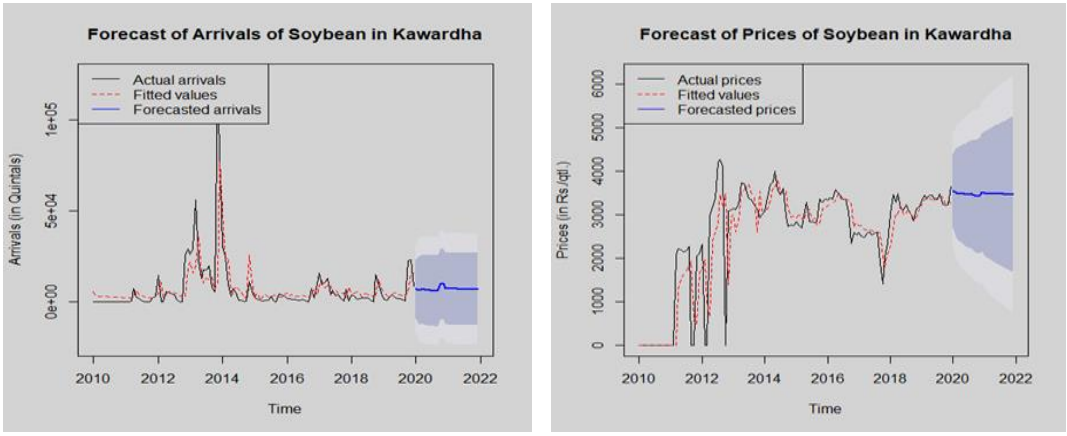

Fig. 4.2: Forecasts of Arrivals and Prices of Soybean in Kawardha Market

From the Table 4.3, the highest forecasted arrivals of soybean for Kawardha are expected to be 10286.94 quintals and 7418.86 quintals respectively in the months of November, 2020 and January, 2021 with respective forcasted prices to be Rs. 3435.18/quintal and Rs. 3494.74/quintal. However, the maximum prices were found to be Rs.3557.91/quintal in the month of January, 2020 and Rs. 3494.74/quintal in the month of January, 2021.

4.2 Results for Arrivals and Prices of Oilseeds in Bemetara Market

4.2.1 Soybean

4.2.1.1 Trend in Arrivals and Prices of Soybean in Bemetara Market

Time series data for arrivals of soybean in Bemetara has been presented in Fig. 4.3: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 92616 quintals in November 2013 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of soybean have also been plotted over the observed time series.

The linearized trend in the arrivals of soybean in Bemetara has been indicated by dark-green line in the graph shown in Fig. 4.3: (e). It could be seen that the arrivals of soybean in Bemetara had shown a decreasing trend over the years.

Similarly time series data for prices of soybean in Bemetara has been presented in Fig. 4.3: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs.4287.5 in May 2016 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of soybean have also been plottted.

The linearized trend in the prices of soybean in Bemetara has been indicated by dark-green line in the graph shown in Fig. 4.3: (f). It could be seen that the prices of soybean in Bemetara had shown an increasing trend over the years.

4.2.1.2 Seasonality pattern in Arrivals and Prices of Soybean in Bemetara Market

The patterns of variation in arrivals within a year is revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices

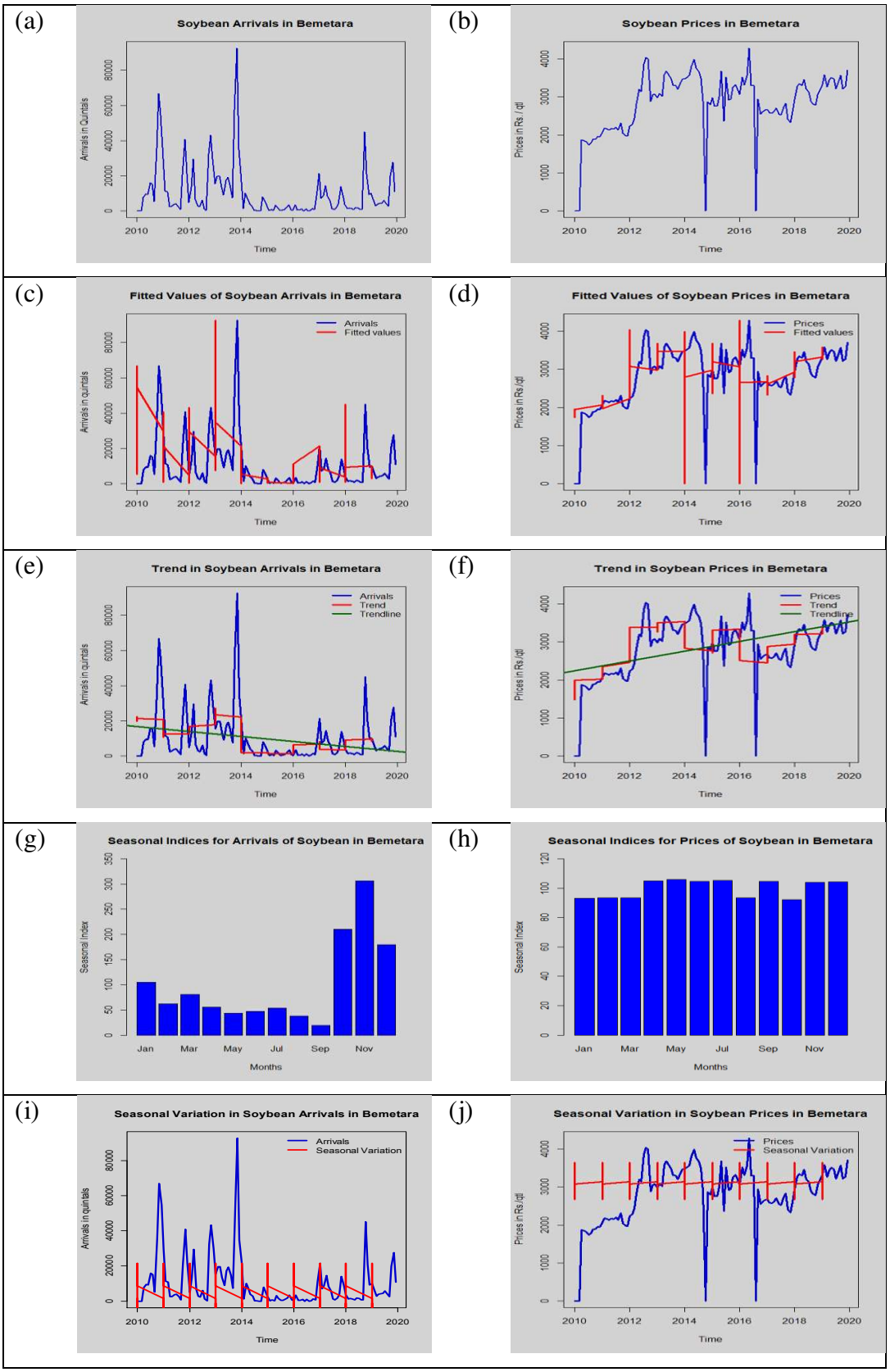

Fig. 4.3: Trend and Seasonality pattern in Arrivals and Prices of Soybean in Bemetara Market

has been shown in Fig. 4.3: (g). The seasonal variation has been plotted in the graph of soybean arrivals in Bemetara.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.3: (h). The seasonal variation has been plotted in the graph of soybean prices in Bemetara.

4.2.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Soybean in Bemetara Market

By fitting different linear and non-linear time series models, we got following results for arrivals of soybean in Bemetara market were obtained as presented in the Table 4.4.

Table 4.4: Parameters of Fitted Model of Arrivals of Soybean in Bemetara Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-Value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	2896764**	-1419*	-	-	R^2 = 0.074**	P= 0.002	14466.2	9672.3	11841.2
	2nd order	10482 14202NS	-1039 242NS	257.5NS	-	R^2 = 0.090**	P= 0.003	14403.7	9529.1	12746.9
	3rd order	16 387.7***	260 2.64NS	-159 9.1NS	137 .5NS	R^2 = 0.116***	P= 0.002	14255.2	9234.0	10735.5
2.	Linearized Compound	4.72 x 10^{30} NS	0.96NS	-	-	R^2 = 0.001NS	P= 0.694	16855.3	9193.8	24953.6
3.	Linearized Inverse	-285 0650**	57.63 x 10^{8} **	-	-	R^2 = 0.074**	P= 0.002	14465.5	9671.7	21845.9
4.	Linearized Logarithmic	2177 1189**	-286 0207**	-	-	R^2 = 0.074**	P= 0.002	14465.8	9672.0	21843.0
5.	Linearized Power	-	-62.8NS	-	-	R^2 = 0.001NS	P= 0.694	16855.2	9193.7	24958.6
6.	Linearized Exponential	4.72 x 10^{30} NS	-0.0NS	-	-	R^2 = 0.001NS	P= 0.694	16855.3	9193.8	24953.6
7.	Linearized Growth	70.63NS	-0.0NS	-	-	R^2 = 0.001NS	P= 0.694	16855.3	9193.8	24953.6
8.	Linearized S-curve	-55.08NS	1268 84.6NS	-	-	R^2 = 0.001NS	P= 0.694	16855.0	9193.6	24963.6
9.	Exponential Smoothing	0.99	-	-	-	χ^2=71.3	P< 0.000	12751.5	7226.3	21991.5
10.	ARIMA (2,1,2) (1,0,1) [12]	-	-	-	-	χ^2=3.1	P< 0.000 AIC= 2548.3	9850.6	6156.9	15821.2

Note:- Polynomial models upto 3rd order are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.4, although many linearized models have significant R^2 values, the ARIMA(2,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) and with (AIC=2548.3), as indicated above, among various models fitted apart from lowest error measures like RMSE (9850.68), MAE (6156.9) and MAPE (51821.2). Thus, ARIMA model is chosen as best model for forecasting of soybean arrivals in Bemetara market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of soybean in Bemetara market were obtained as presented in the Table 4.5.

Table 4.5: Parameters of Fitted Model of Prices of Soybean in Bemetara Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-258203.7***	129.6***	-	-	R^2= 0.202***	P< 0.000	745.4	515.7	20836.2
	2nd order	-1.5 x 10^{8***}	1.52 x10^{5***}	-3.7***	-	R^2= 0.312***	P< 0.000	694.9	465.5	19447.9
	3rd order	12805.86***	1384.4***	-305.6***	19.8***	R^2= 0.489***	P< 0.000	601.1	389.1	16570.4
2.	Linearized Compound	2.07 x10^{-125**}	1.1**	-	-	R^2= 0.058**	P= 0.007	1156.6	973.4	12508.4
3.	Linearized Inverse	26490.5***	-5.26 x10^{8***}	-	-	R^2= 0.202***	P< 0.000	745.2	515.4	20831.3
4.	Linearized Logarithmic	-1984017***	2611 47.1***	-	-	R^2= 0.202***	P< 0.000	745.3	515.5	20833.8
5.	Linearized Power	-	294.8**	-	-	R^2= 0.058**	P= 0.007	1156.5	973.4	12506.8
6.	Linearized Exponential	2.07 x10^{-125}	0.1**	-	-	R^2= 0.058**	P= 0.007	1156.6	973.4	12508.4
7.	Linearized Growth	-287.0**	0.1**	-	-	R^2= 0.058**	P= 0.007	1156.6	973.4	12508.4
8.	Linearized S-curve	302.5**	-5941 97.6**	-	-	R^2= 0.058**	P= 0.007	1156.4	973.3	12505.1
9.	Exponential Smoothing	0.4	-	-	-	χ^2= 0.003	P< 0.000	585.1	318.4	11288.8
10.	ARIMA (0,1,1) (1,0,1) [12]	-	-	-	-	χ^2= 0.110	P< 0.000 AIC= 1857.5	566.3	302.3	11000.8
Note:- Polynomial models upto 3rd order are significant.										

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.5, although many linearized models have significant R^2 values, the ARIMA(0,1,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1857.5), as indicated above, among various models fitted apart from lowest error measures like RMSE (566.3), MAE (302.3) and MAPE (11000.8). Thus, ARIMA model is chosen as best model for forecasting of soybean prices in Bemetara market.

4.2.1.4 Forecasting of Arrivals and Prices of Soybean in Bemetara Market

After identification of the model, forecasting of arrivals and prices of soybean has been done. The best ARIMA model has been used to forecast the arrivals and prices of soybean in Bemetara market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.6 and also depitcted in graph in Fig 4.4.

Table 4.6: Forecasted values of Arrivals and Prices of Soybean in Bemetara Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	9511.40	9760.62	3567.65	3694.46
February	6840.39	7144.33	3635.26	3758.09
March	5797.26	6406.30	3604.95	3729.57
April	6429.72	6819.37	3739.32	3856.01
May	5612.38	6210.66	3858.10	3967.78
June	5707.70	6202.03	3696.51	3815.72
July	5509.05	6099.22	3739.28	3855.97
August	4690.19	5312.29	3537.01	3665.63
September	4152.79	4880.23	3691.66	3811.16
October	18218.85	17359.53	3455.37	3588.81
November	18365.74	17519.00	3613.92	3738.00
December	10520.28	10515.55	3674.32	3794.84

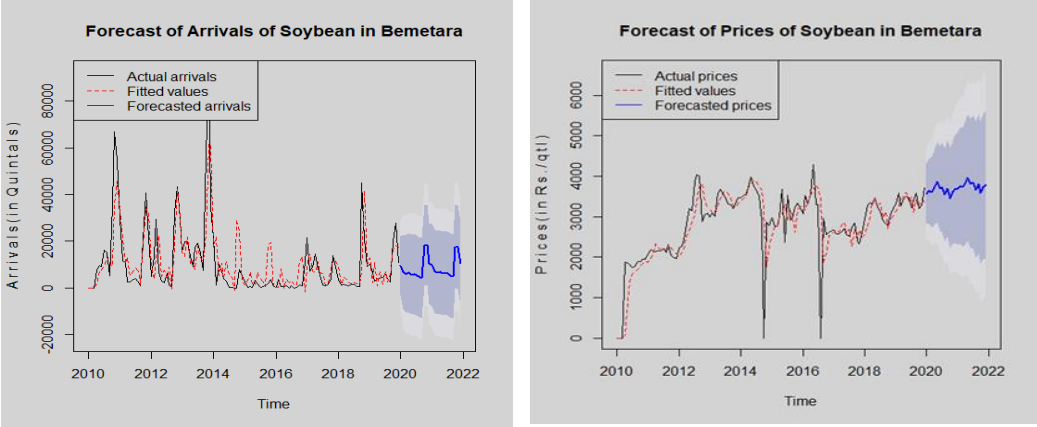

Fig. 4.4: Forecasts of Arrivals and Prices of Soybean in Bemetara Market

From the Table 4.6, the highest forecasted arrivals of soybean for Bemetara are expected to be 18365.74 quintals and 17519.00 quintals respectively in the month of November, 2020 and November, 2021 with respective forcasted prices to be Rs. 3613.92/quintal and Rs. 3738.00/quintal. However, the maximum prices were found to be Rs. 3858.10/quintal in the month of May, 2020 and Rs. 3967.78/quintal in the month of May, 2021.

4.3 Results for Arrivals and Prices of Oilseeds in Bhatapara Market

4.3.1 Soybean

4.3.1.1 Trend in Arrivals and Prices of Soybean in Bhatapara Market

Time series data for arrivals of soybean in Bhatapara has been presented in Fig. 4.5: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 7275 quintals in November 2013 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of soybean have also been plotted over the observed time series.

The linearized trend in the arrivals of soybean in Bhatapara has been indicated by dark-green line in the graph shown in Fig. 4.5: (e). It could be seen that the arrivals of soybean in Bhatapara had shown an increasing trend in arrivals over the years.

Similarly time series data for prices of soybean in Bhatapara has been presented in Fig.4.5: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs.4351 in August 2013 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of soybean have also been plottted.

The linearized trend in the prices of soybean in Bhatapara has been indicated by dark-green line in the graph shown in Fig.4.5: (f). It could be seen that the prices of soybean in Bhatapara had shown an increasing trend over the years.

4.3.1.2 Seasonality pattern in Arrivals and Prices of Soybean in Bhatapara Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices

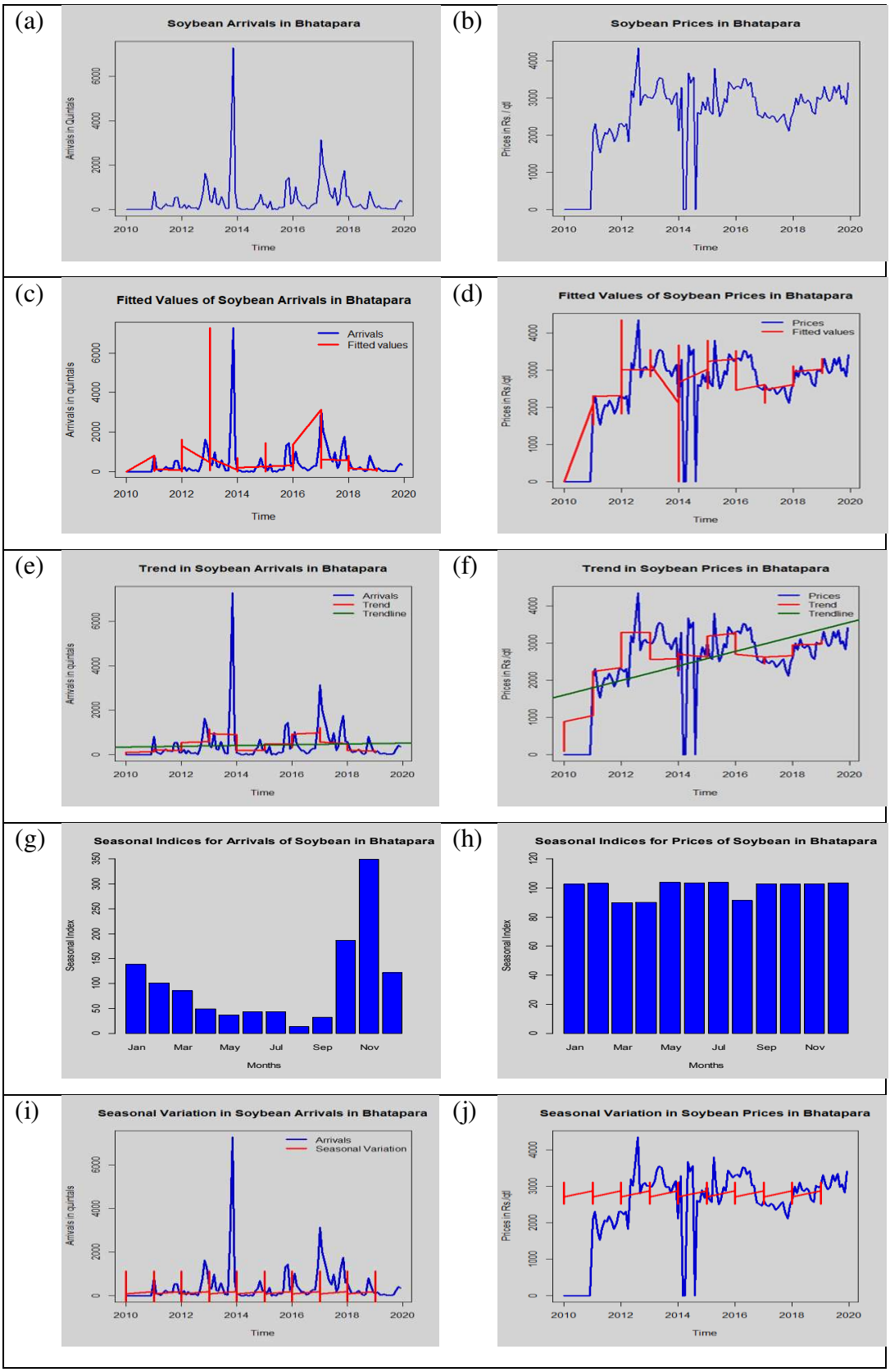

Fig. 4.5: Trend and Seasonality pattern in Arrivals and Prices of Soybean in Bhatapara Market

has been shown in Fig. 4.5: (g). The seasonal variation has been plotted in the graph of soybean arrivals in Bhatapara.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.5: (h). The seasonal variation has been plotted in the graph of soybean prices in Bhatapara.

4.3.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Soybean in Bhatapara Market

By fitting different linear and non-linear time series models, we got following results for arrivals of soybean in Bhatapara market were obtained as presented in the Table 4.7.

Table 4.7: Parameters of Fitted Model of Arrivals of Soybean in Bhatapara Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-362 26.0^{NS}	18.1^{NS}	-	-	R^2= 0.004^{NS}	P= 0.489	825.9	442.2	10411.6
	2nd order	-9.55 x10^{7*}	9.48 x10^{4*}	-2.3*	-	R^2= 0.047$^{\$}$	P= 0.058	811.2	420.0	6175.8
	3rd order	62.6^{NS}	208.0^{NS}	-17.0^{NS}	-0.4^{NS}	R^2= 0.027^{NS}	P= 0.128	814.6	420.0	6392.7
2.	Linearized Compound	2.17x 10$^{-280***}$	1.3***	-	-	R^2= 0.139***	P< 0.000	887.1	385.9	11440.0
3.	Linearized Inverse	372 06.5^{NS}	-7.41 x10$^{7\,NS}$	-	-	R^2= 0.004^{NS}	P= 0.488	825.9	442.2	10403.0
4.	Linearized Logarithmic	-2789 27.1^{NS}	367 16.2^{NS}	-	-	R^2= 0.004^{NS}	P= 0.488	825.9	442.2	10407.3
5.	Linearized Power	-	648.7***	-	-	R^2= 0.139***	P <0.000	887.1	385.9	11436.0
6.	Linearized Exponential	2.17x 10$^{-280***}$	0.3***	-	-	R^2= 0.139***	P< 0.000	887.1	385.9	11440.0
7.	Linearized Growth	-64 3.9***	0.3***	-	-	R^2= 0.139***	P< 0.000	887.1	385.9	11440.0
8.	Linearized S-curve	653.5***	-130 7783***	-	-	R^2= 0.139***	P< 0.000	887.0	385.9	11433.0
9.	Exponential Smoothing	0.1	-	-	-	χ^2= 37.321	P= 0.007	821.5	412.8	7575.8
10.	ARIMA (2,0,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.001	P< 0.000 AIC= 1936.42	708.7	340.7	7032.9

Note:- Polynomial models upto 2nd order are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.7, although many linearized models have significant R^2 values, the ARIMA(2,0,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1936.42), as indicated above, among various models fitted apart from lowest error measures like RMSE (708.7), MAE (340.7) and MAPE (7032.9). Thus, ARIMA model is chosen as best model for forecasting of soybean arrivals in Bhatapara market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of soybean in Bhatapara market were obtained as presented in the Table 4.8.

Table 4.8: Parameters of Fitted Model of Prices of Soybean in Bhatapara Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-3921 92.3***	195.9***	-	-	R^2= 0.286***	P< 0.000	895.3	685.0	43944.3
	2nd order	-2.57 x10^8***	2.55 x10^5***	-6.3***	-	R^2= 0.478***	P< 0.000	769.0	570.4	31280.7
	3rd order	218.4^NS	1904.0***	-3 96.6***	24.6***	R^2= 0.648***	P< 0.000	633.7	374.4	19719.8
2.	Linearized Compound	0***	1.64***	-	-	R^2= 0.252***	P< 0.000	2655.1	2175.4	57653.0
3.	Linearized Inverse	3975 60.8***	-7.9 x10^8***	-	-	R^2= 0.286***	P< 0.000	894.9	684.9	43906.2
4.	Linearized Logarithmic	-300 1787***	3948 76.4***	-	-	R^2= 0.286***	P< 0.000	895.1	685.0	43925.3
5.	Linearized Power	-	10008***	-	-	R^2= 0.253***	P< 0.000	2654.7	2175.3	57631.0
6.	Linearized Exponential	0***	0.50***	-	-	R^2= 0.252***	P <0.000	2655.1	2175.4	57653.0
7.	Linearized Growth	-100 0.6***	0.50***	-	-	R^2= 0.252***	P< 0.000	2655.1	2175.4	57653.0
8.	Linearized S-curve	101 5.4***	-203 1860***	-	-	R^2= 0.252***	P< 0.000	2654.2	2175.2	57609.0
9.	Exponential Smoothing	0.3	-	-	-	χ^2= 1.13	P< 0.000	650.7	362.5	12981.0
10.	ARIMA (2,0,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.23	P< 0.000 AIC= 1885.8	625.6	355.2	11306.2
Note:- Polynomial models upto 3rd order are significant.										

Notations:-	
*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.8, although many linearized models have significant R^2 values, the ARIMA(2,0,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1885.8), as indicated above, among various models fitted apart from lowest error measures like RMSE (625.6), MAE (355.2) and MAPE (11306.2). Thus, ARIMA model is chosen as best model for forecasting of soybean prices in Bhatapara market.

4.3.1.4 Forecasting of Arrivals and Prices of Soybean in Bhatapara Market

After identification of the model, forecasting of arrivals and prices of soybean has been done. The best ARIMA model has been used to forecast the arrivals and prices of soybean in Bhatapara market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.9 and also depitcted in graph in Fig 4.6.

Table 4.9: Forecasted values of Arrivals and Prices of Soybean in Bhatapara Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	509.31	502.74	3257.21	3143.14
February	392.07	418.61	3104.97	3149.09
March	353.53	378.56	3087.49	3151.05
April	277.08	299.45	3124.07	3149.32
May	251.09	270.46	3161.16	3147.27
June	265.99	282.24	3157.65	3145.94
July	270.89	284.69	3160.89	3146.65
August	204.25	217.19	3139.01	3146.80
September	248.81	259.37	3154.75	3147.84
October	592.23	595.67	3151.22	3147.63
November	935.64	932.17	3164.78	3147.88
December	444.71	448.57	3135.04	3146.62

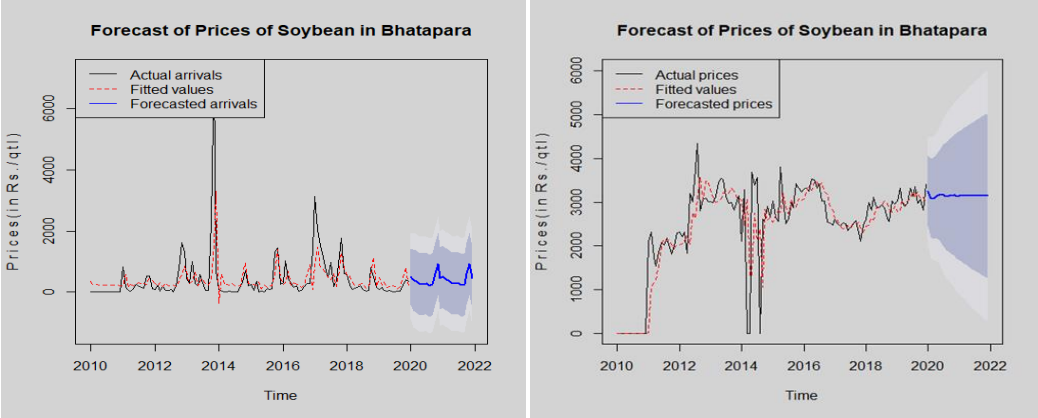

Fig. 4.6: Forecasts of Arrivals and Prices of Soybean in Bhatapara Market

From the Table 4.9, the highest forecasted arrivals of soybean for Bhatapara are expected to be 935.64 quintals and 932.17 quintals respectively in the month of November, 2020 and November, 2021 with respective forcasted prices to be Rs. 3164.78/quintal and Rs. 3147.88/quintal. However, the maximum prices were found to be Rs. 3257.21/quintal in the month of January, 2020 and Rs. 3151.05/quintal in the month of March, 2021.

4.3.2 Mustard

4.3.2.1 Trend in Arrivals and Prices of Mustard in Bhatapara Market

Time series data for arrivals of mustard in Bhatapara has been presented in Fig. 4.7: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 3420 quintals in May 2019 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of mustard have also been plotted over the observed time series.

The linearized trend in the arrivals of mustard in Bhatapara has been indicated by dark-green line in the graph shown in Fig. 4.7: (e). It could be seen that the arrivals of mustard in Bhatapara had shown an increasing trend in arrivals over the years.

Similarly time series data for prices of mustard in Bhatapara has been presented in Fig. 4.7: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs.4651 in October 2015 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of mustard have also been plottted.

The linearized trend in the prices of mustard in Bhatapara has been indicated by dark-green line in the graph shown in Fig. 4.7: (f). It could be seen that the prices of mustard in Bhatapara had shown an increasing trend over the years.

4.3.2.2 Seasonality pattern in Arrivals and Prices of Mustard in Bhatapara Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.7: (g). The seasonal variation has been plotted in the graph of mustard arrivals in Bhatapara.

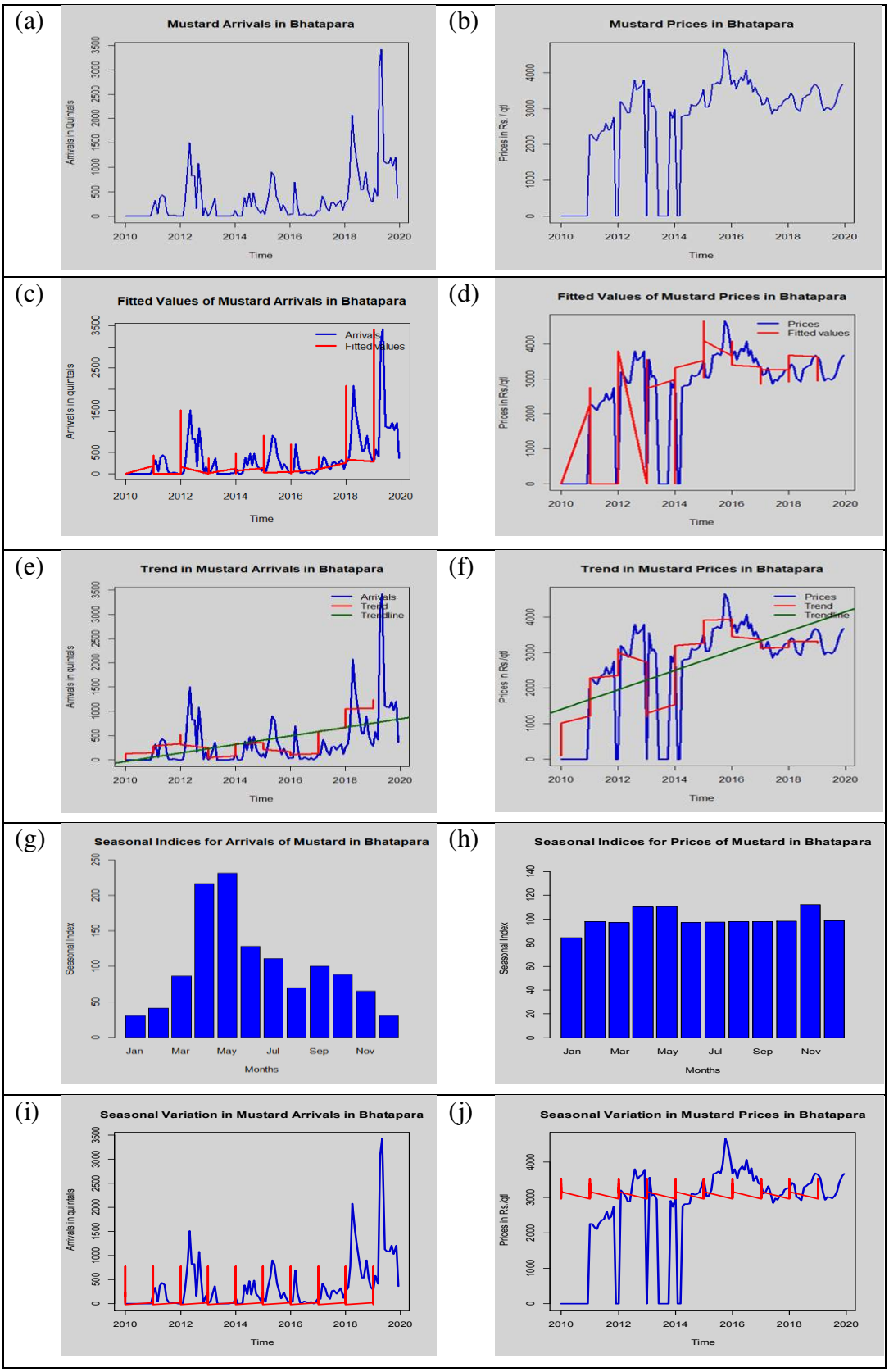

Fig. 4.7: Trend and Seasonality pattern in Arrivals and Prices of Mustard in Bhatapara Market

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.7: (h). The seasonal variation has been plotted in the graph of mustard prices in Bhatapara.

4.3.2.3 Identifying the Best Forecasting Model for Arrivals and Prices of Mustard in Bhatapara Market

By fitting different linear and non-linear time series models, we got following results for arrivals of mustard in Bhatapara market were obtained as presented in the Table 4.10.

Table 4.10: Parameters of Fitted Model of Arrivals of Mustard in Bhatapara

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-1770 79.7^{***}	88.0^{***}	-	-	R^2= 0.214^{***}	P< 0.000	488.8	316.6	5463.7
	2nd order	9.42 $x10^{7***}$	-9.36 $x10^{4***}$	2.3^{***}	-	R^2= 0.309^{***}	P< 0.000	460.0	295.3	7175.4
	3rd order	-1.8^{***}	326.3^{***}	-107.8^{***}	9.7^{***}	R^2= 0.407^{***}	P< 0.000	428.2	257.0	4901.5
2.	Linearized Compound	0^{***}	1.7^{***}	-	-	R^2= 0.368^{***}	P< 0.000	483.5	256.6	7552.6
3.	Linearized Inverse	1776 50.6^{***}	-3.5 $x10^{8***}$	-	-	R^2= 0.213^{***}	P< 0.000	488.9	316.7	5474.0
4.	Linearized Logarithmic	-134 9056^{***}	177 365.1^{***}	-	-	R^2= 0.213^{***}	P< 0.000	488.8	316.6	5468.8
5.	Linearized Power	-	1171.09^{***}	-	-	R^2= 0.368^{***}	P< 0.000	483.6	256.7	7556.7
6.	Linearized Exponential	0^{***}	0.58^{***}	-	-	R^2= 0.368^{***}	P< 0.000	483.5	256.6	7552.6
7.	Linearized Growth	-1 167.0^{***}	0.58^{***}	-	-	R^2= 0.368^{***}	P< 0.000	483.5	256.6	7552.6
8.	Linearized S-curve	1175.1^{***}	-2.35 $x10^{6***}$	-	-	R^2= 0.368^{***}	P< 0.000	483.7	256.8	7560.8
9.	Exponential Smoothing	0.80	-	-	-	χ^2= 0.381	P< 0.000	427.0	222.9	4038.5
10.	ARIMA (1,1,1) (1,0,0) [12]	-	-	-	-	χ^2= 0.009	P< 0.000 AIC= 1756.1	367.9	213.5	3275.4

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.10, although many linearized models have significant R^2 values, the ARIMA(1,1,1,)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1756.1), as indicated above, among various models fitted apart from lowest error measures like RMSE (367.9), MAE (213.5) and MAPE (3275.4). Thus, ARIMA model is chosen as best model for forecasting of mustard arrivals in Bhatapara market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of mustard in Bhatapara market were obtained as presented in the Table 4.11.

Table 4.11: Parameters of Fitted Model of Prices of Mustard in Bhatapara Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-550 449.7***	274.6***	-	-	0.355***	0.000	1070.3	871.2	64677.1
	2nd order	-2.5 x10^8***	2.48 x10^5***	-6.1***	-	0.470***	0.000	974.2	671.0	55005.4
	3rd order	479.6$	1161.8***	-1 58.9$	7.2NS	0.479***	0.000	969.9	640.5	53240.7
2.	Linearized Compound	0***	1.88***	-	-	R^2= 0.289***	P< 0.000	3293.1	2482.2	51607.0
3.	Linearized Inverse	5561 17.1***	-1.11 x10^9***	-	-	R^2= 0.356***	P< 0.000	1069.8	870.8	64632.9
4.	Linearized Logarithmic	-420 6812***	553 283.4***	-	-	R^2= 0.356***	P< 0.000	1070.0	871.0	64655.0
5.	Linearized Power	-	1281.7***	-	-	R^2= 0.290***	P< 0.000	3290.4	2480.9	51618.0
6.	Linearized Exponential	0***	0.6***	-	-	R^2= 0.289***	P< 0.000	3293.1	2482.2	51607.0
7.	Linearized Growth	-12 74.8***	0.6***	-	-	R^2= 0.28***	P< 0.000	3293.1	2482.2	51607.0
8.	Linearized S-curve	1288.6***	-2.58 x10^6***	-	-	R^2= 0.290***	P< 0.000	3287.6	2479.6	51628.0
9.	Exponential Smoothing	0.5	-	-	-	χ^2= 1.433	P< 0.000	825.5	422.5	27486.3
10.	ARIMA (0,1,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.010	P< 0.000 AIC= 1936.6	787.1	443.5	25152.1

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.11, although many linearized models have significant R^2 values, the ARIMA(0,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1936.6), as indicated above, among various models fitted apart from lowest error measures like RMSE (787.1), MAE (443.5) and MAPE (25152.1). Thus, ARIMA model is chosen as best model for forecasting of mustard prices in Bhatapara market.

4.3.2.4 Forecasting of Arrivals and Prices of Mustard in Bhatapara Market

After identification of the model, forecasting of arrivals and prices of mustard has been done. The best ARIMA model has been used to forecast the arrivals and prices of mustard in Bhatapara market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.12 and also depitcted in graph in Fig 4.8.

Table 4.12: Forecasted values of Arrivals and Prices of Mustard in Bhatapara Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	518.01	851.33	3532.01	3414.31
February	753.28	959.31	3461.72	3416.96
March	733.27	950.17	3526.14	3457.14
April	1987.84	1525.53	3490.64	3434.99
May	2161.92	1605.38	3482.23	3429.75
June	1116.81	1126.10	3549.32	3471.59
July	1107.19	1121.70	3498.16	3439.68
August	1104.93	1120.66	3495.67	3438.13
September	1161.94	1146.81	3463.80	3418.25
October	1082.53	1110.39	3429.55	3396.89
November	1166.45	1148.88	3340.13	3341.12
December	778.73	971.07	3361.16	3354.24

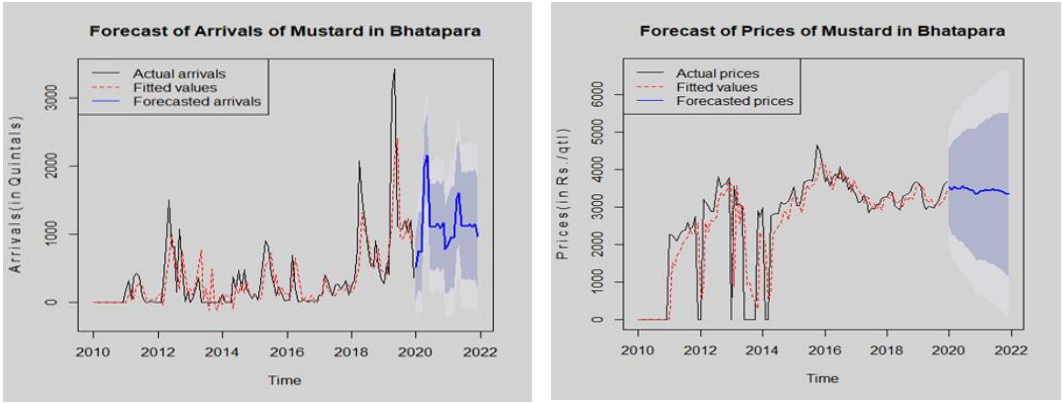

Fig. 4.8: Forecasts of Arrivals and Prices of Mustard in Bhatapara Market

From the Table 4.12, the highest forecasted arrivals of mustard for Bhatapara are expected to be 2161.92 quintals and 1605.38 quintals respectively in the month of May, 2020 and May, 2021 with respective forcasted prices to be Rs. 3482.23/quintal and Rs. 3429.75/quintal. However, the maximum prices were found to be Rs. 3532.01/quintal in the month of January, 2020 and Rs. 3471.59/quintal in the month of June, 2021.

4.4 Results for Arrivals and Prices of Oilseeds in Basna Market

4.4.1 Groundnut

4.4.1.1 Trend in Arrivals and Prices of Groundnut in Basna Market

Time series data for arrivals of groundnut in Basna has been presented in Fig. 4.9: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 1039 quintals in June 2018 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut has been plotted there.

The linearized trend in the arrivals of groundnut in Basna has been indicated by dark-green line in the graph shown in Fig. 4.9: (e). It could be seen that the arrivals of groundnut in Basna had shown a decreasing trend over the years.

Similarly time series data for prices of groundnut in Basna has been presented in Fig. 4.9: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs.4800 in September 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Basna has been indicated by dark-green line in the graph shown in Fig. 4.9: (f). It could be seen that the prices of groundnut in Basna had shown a decreasing trend over the years.

4.4.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Basna Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal

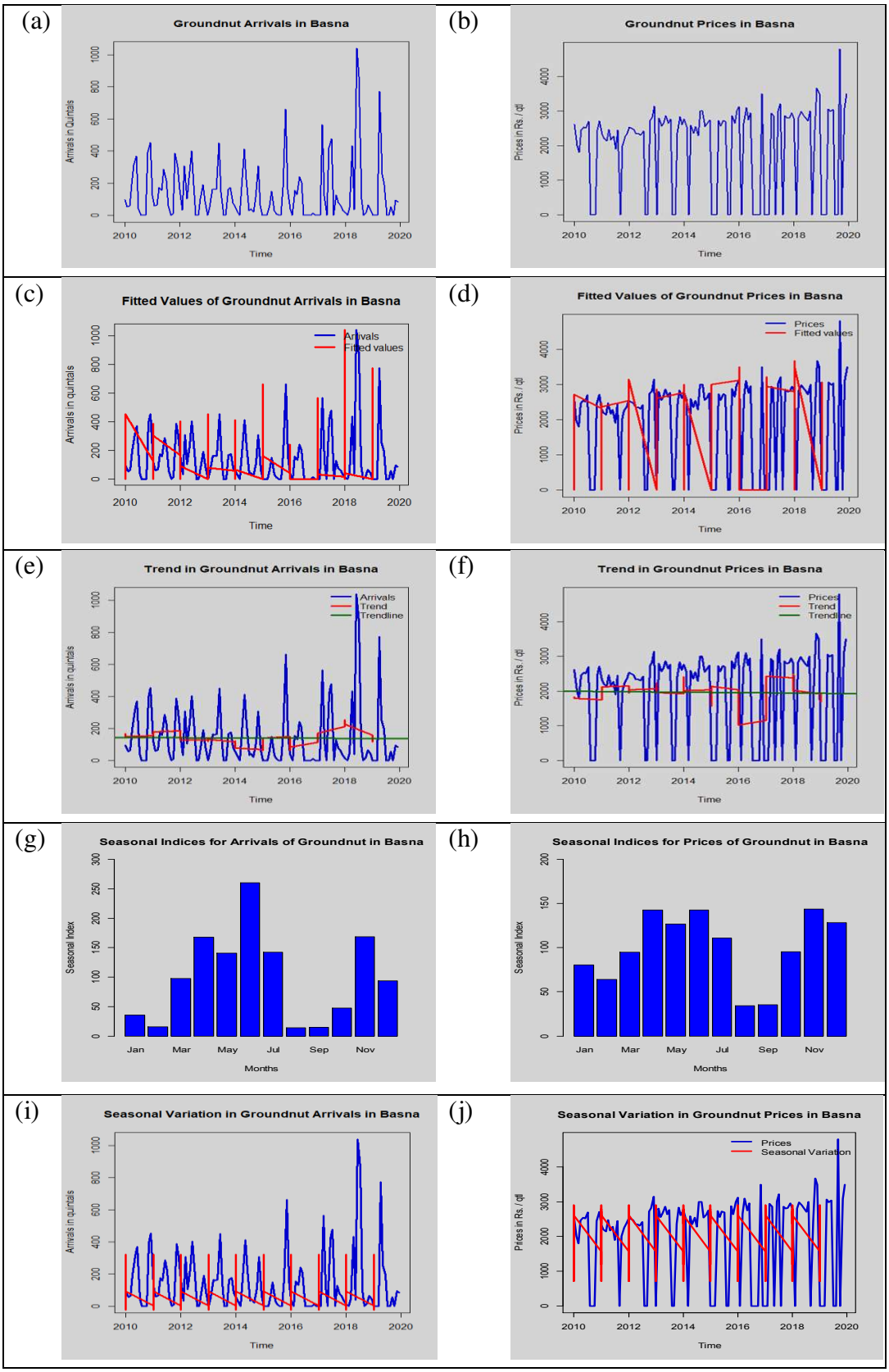

Fig. 4.9: Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Basna Market

indices has been shown in Fig. 4.9: (g). The seasonal variation has been plotted in the graph of groundnut arrivals in Basna.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.9: (h). The seasonal variation has been plotted in the graph of groundnut prices in Basna.

4.4.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Basna Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Basna market were obtained as presented in the Table 4.13.

Table 4.13: Parameters of Fitted Model of Arrivals of Groundnut in Basna Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	1278.5^{NS}	-0.5^{NS}	-	-	$R^2=0.000^{NS}$	P= 0.924	187.4	131.6	7721.0
	2nd order	$1032 6636^{NS}$	$-102 51.6^{NS}$	2.5^{NS}	-	$R^2=0.009^{NS}$	P= 0.556	187.2	132.2	7744.7
	3rd order	175.8^{NS}	-30.5^{NS}	4.6^{NS}	-0.1^{NS}	$R^2=0.010^{NS}$	P= 0.754	188.0	132.4	7760.4
2.	Linearized Compound	$3.59 x10^{153*}$	0.8^{*}	-	-	$R^2=0.036^{*}$	P= 0.035	217.4	127.0	1464.2
3.	Linearized Inverse	-1017^{NS}	$2326 899^{NS}$	-	-	$R^2=0.000^{NS}$	P= 0.923	187.4	131.6	7720.6
4.	Linearized Logarithmic	$887 1.7^{NS}$	$-114 7.8^{NS}$	-	-	$R^2=0.000^{NS}$	P= 0.924	187.4	131.6	7720.8
5.	Linearized Power	-	$-3 50.3^{*}$	-	-	$R^2=0.036^{*}$	P= 0.035	217.4	127.0	1464.2
6.	Linearized Exponential	$3.59 x10^{153*}$	-0.1^{*}	-	-	$R^2=0.036^{*}$	P= 0.035	217.4	127.0	1464.2
7.	Linearized Growth	353.5^{*}	-0.1^{*}	-	-	$R^2=0.036^{*}$	P= 0.035	217.4	127.0	1464.2
8.	Linearized S-curve	-347.0^{*}	$7057 71.8^{*}$	-	-	$R^2=0.036^{*}$	P= 0.035	217.4	127.0	1464.2
9.	Exponential Smoothing	0.01	-	-	-	$\chi^2=53.2$	P< 0.000	189.3	129.9	6774.8
10.	ARIMA (0,0,1) (1,0,2) [12]	-	-	-	-	$\chi^2=9.4$	P< 0.000 AIC= 1570.2	154.9	105.6	1461.0

Note:- None of the Polynomial models are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.13, although many linearized models have significant R^2 values, the ARIMA(0,0,1)(1,0,2)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1570.2), as indicated above, among various models fitted apart from lowest error measures like RMSE (154.9), MAE (105.6) and MAPE (1461.0). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Basna market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Basna market were obtained as presented in the Table 4.14.

Table 4.14: Parameters of Fitted Model of Prices of Groundnut in Basna Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	173 3 0.8^{NS}	-7.6^{NS}	-	-	R^2= 0.000^{NS}	P= 0.852	1272.0	1082.9	107824.3
	2nd order	-855 2290^{NS}	8500.3^{NS}	-2.1^{NS}	-	R^2= 0.000^{NS}	P= 0.971	1277.3	1082.1	107803.1
	3rd order	1871.9^{NS}	201.1^{NS}	-57.6^{NS}	4.1^{NS}	R^2= 0.003^{NS}	P= 0.938	1280.7	1077.2	107395.6
2.	Linearized Compound	2.33 $x10^{196\,NS}$	0.8^{NS}	-	-	R^2= 0.027^{NS}	P= 0.075	2109.3	1830.1	107824.6
3.	Linearized Inverse	-133 83.8^{NS}	3092 3589^{NS}	-	-	R^2= 0.000^{NS}	P= 0.857	1272.0	1082.9	107824.4
4.	Linearized Logarithmic	118 807.5^{NS}	-1535 57.3^{NS}	-	-	R^2= 0.027^{NS}	P= 0.075	2109.3	1830.1	141013.0
5.	Linearized Power	-	-446.5^{NS}	-	-	R^2= 0.027^{NS}	P= 0.075	2109.3	1830.1	141008.0
6.	Linearized Exponential	2.3^{NS}	-0.2^{NS}	-	-	R^2= 0.027^{NS}	P= 0.075	2109.3	1830.1	141008.0
7.	Linearized Growth	452.1^{NS}	-0.2^{NS}	-	-	R^2= 0.027^{NS}	P= 0.075	2109.3	1830.1	141008.0
8.	Linearized S-curve	899 -441.0^{NS}	604.7^{NS}	-	-	R^2= 0.027^{NS}	P= 0.075	2109.3	1830.1	141018.0
9.	Exponential Smoothing	0.03	-	-	-	χ^2=49.6	P< 0.000	1304.9	1060.0	115313.4
10.	ARIMA (0,0,2) (1,0,1) [12]	-	-	-	-	χ^2=0.0	P< 0.000 AIC= 2052.3	1170.8	952.5	94947.1
Note:- None of the Polynomial modesl are significant.										

Notations:-	
*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.14, although many linearized models have significant R^2 values, the ARIMA(0,0,2)(1,0,1) model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2052.3), as indicated above, among various models fitted apart from lowest error measures like RMSE (1170.8), MAE (952.57) and MAPE (94947.1). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Basna market.

4.4.1.4 Forecasting of Arrivals and Prices of Groundnut in Basna Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Basna market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.15 and also depitcted in graph in Fig 4.10.

Table 4.15: Forecasted values of Arrivals and Prices of Groundnut in Basna Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	58.62	91.11	1615.43	1647.51
February	58.24	80.61	1155.93	1259.95
March	119.51	136.18	1777.35	1786.91
April	376.85	195.39	2501.94	2474.43
May	210.56	170.46	2204.30	2192.02
June	117.87	242.70	2473.99	2447.91
July	16.17	158.57	1913.42	1916.02
August	41.95	78.19	1263.06	1298.93
September	86.49	81.13	1671.26	1686.24
October	75.83	100.76	1786.02	1795.14
November	168.39	184.75	2607.45	2574.54
December	128.57	137.40	2451.62	2426.69

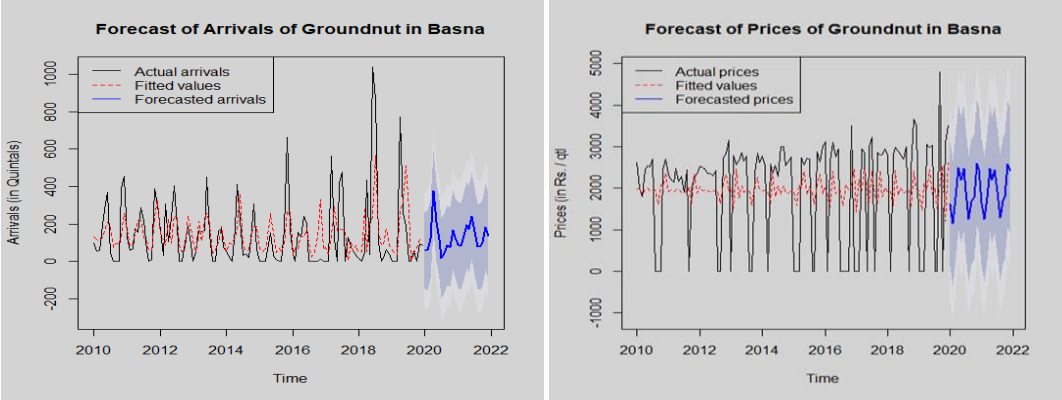

Fig. 4.10: Forecasts of Arrivals and Prices of Groundnut in Basna Market

From the Table 4.15, the highest forecasted arrivals of groundnut for Basna are expected to be 376.85 quintals and 242.70 quintals respectively in the month of April, 2020 and June, 2021 with respective forcasted prices to be Rs. 2501.94/quintal and Rs. 2447.91/quintal. However, the maximum prices were found to be Rs. 2607.45/quintal in the month of November, 2020 and Rs. 2574.54/quintal in the month of November, 2021.

4.5 Results for Arrivals and Prices of Oilseeds in Rajnandgaon Market

4.5.1 Soybean

4.5.1.1 Trend in Arrivals and Prices of Soybean in Rajnandgaon Market

Time series data for arrivals of soybean in Rajnandgaon has been presented in Fig. 4.11: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 125114 quintals in November 2014 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of soybean have also been plotted over the observed time series.

The linearized trend in the arrivals of soybean in Rajnandgaon has been indicated by dark-green line in the graph shown in Fig. 4.11: (e). It could be seen that the arrivals of soybean in Rajnandgaon had shown a decreasing trend in arrivals over the years.

Similarly time series data for prices of soybean in Rajnandgaon has been presented in Fig.4.11: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs.4267.88 in August 2012 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of soybean have also been plottted.

The linearized trend in the prices of soybean in Rajnandgaon has been indicated by dark-green line in the graph shown in Fig. 4.11: (f). It could be seen that the prices of soybean in Rajnandgaon had shown an increasing trend over the years.

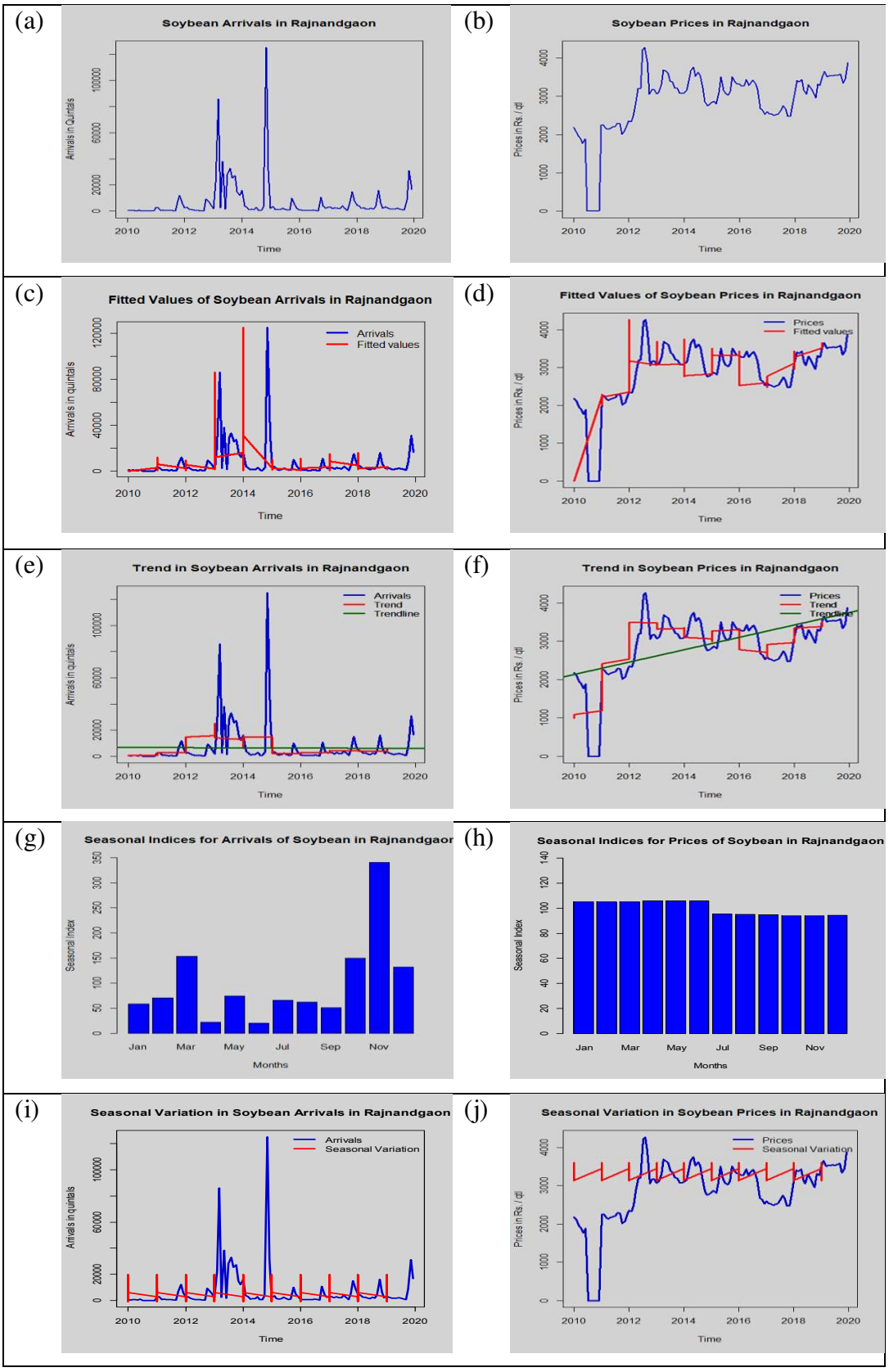

Fig. 4.11: Trend and Seasonality pattern in Arrivals and Prices of Soybean in Rajnandgaon Market

4.5.1.2 Seasonality pattern in Arrivals and Prices of Soybean in Rajnandgaon Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.11: (g). The seasonal variation has been plotted in the graph of soybean arrivals in Rajnandgaon.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.11: (h). The seasonal variation has been plotted in the graph of soybean prices in Rajnandgaon.

4.5.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Soybean in Rajnandgaon Market

By fitting different linear and non-linear time series models, we got following results for arrivals of soybean in Rajnandgaon market were obtained as presented in the Table 4.16.

Table 4.16: Parameters of Fitted Model of Arrivals of Soybean in Rajnandgaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	167045.5^{NS}	-79.7^{NS}	-	-	R^2= 0.000^{NS}	P= 0.850	15325.6	7590.3	68838.0
	2nd order	-1.60 x10^{9} *	1648693*	-409.2*	-	R^2= 0.038*	P= 0.974	15093.5	7375.7	49732.0
	3rd order	-3107.2^{NS}	12810**	-3105.3**	19 9.7*	R^2= 0.091*	P= 0.010	14732.0	7395.9	41610.8
2.	Linearized Compound	1.6 x$10^{-253***}$	1.3***	-	-	R^2= 0.137***	P< 0.000	16128.4	5889.0	42022.0
3.	Linearized Inverse	-151467^{NS}	3.81 x10^{8} ^{NS}	-	-	R^2= 0.000^{NS}	P= 0.872	15325.6	4590.4	68784.0
4.	Linearized Logarithmic	1218124^{NS}	-159256.8^{NS}	-	-	R^2= 0.000^{NS}	P= 0.872	15325.6	7592.3	68811.0
5.	Linearized Power	-	589.7***	-	-	R^2= 0.137***	P< 0.000	16128.3	5889.2	41950.0
6.	Linearized Exponential	1.63***	0.29***	-	-	R^2= 0.137***	P< 0.000	16128.4	5889.0	42022.0
7.	Linearized Growth	-582***	0.29***	-	-	R^2= 0.137***	P< 0.000	16128.4	5889.0	42022.0
8.	Linearized S-curve	597.5***	-1188913***	-	-	R^2=0.137***	P< 0.000	16128.3	5889.5	41879.0
9.	Exponential Smoothing	0.1	-	-	-	χ^2= 2.45	P< 0.000	15124.2	6663.6	41620.0

10.	ARIMA (1,0,0) (1,0,1) [12]	-	-	-	-	χ^2= 0.05	P< 0.000 AIC= 2653.8	14715.8	6736.4	41542.1

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.16, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2653.8), as indicated above, among various models fitted apart from lowest error measures like RMSE (14715.84), MAE (6736.4) and MAPE (41542.1). Thus, ARIMA model is chosen as best model for forecasting of soybean arrivals in Rajnandgaon market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of soybean in Rajnandgaon market were obtained as presented in the Table 4.17.

Table 4.17: Parameters of Fitted Model of Prices of Soybean in Rajnandgaon

S. N.	**Models**	**α**	**β_1**	**β_2**	**β_3**	**R^2/ Test-Statistics**	**P-Value /AIC**	**RMSE**	**MAE**	**MAPE**
1.	Linearized Polynomial 1st order	-3235 43.7^{***}	162^{***}	-	-	R^2= 0.307^{***}	P< 0.000	705.0	474.4	21306.8
	2nd order	-1966 77534^{***}	195 103.1^{***}	-48.3^{***}	-	R^2= 0.482^{***}	P< 0.000	612.0	449.0	15501.2
	3rd order	16 954.5^{***}	84.6^{***}	-366.7^{***}	23.5^{***}	R^2= 0.725^{***}	P< 0.000	447.3	323.9	9555.9
2.	Linearized Compound	1.88 $x10^{-231***}$	1.30^{***}	-	-	R^2= 0.163^{***}	P< 0.000	1705.4	1551.1	5798.2
3.	Linearized Inverse	329 570^{***}	-65815 8802^{***}	-	-	R^2= 0.307^{***}	P< 0.000	704.7	474.1	21290.2
4.	Linearized Logarithmic	-248 1626^{***}	326 56.8^{***}	-	-	R^2= 0.307^{***}	P< 0.000	704.9	474.3	21298.5
5.	Linearized Power	-	539.1^{***}	-	-	R^2= 0.163^{***}	P< 0.000	1705.5	1551.2	5798.3
6.	Linearized Exponential	1.88 $x10^{-231***}$	0.2^{***}	-	-	R^2= 0.163^{***}	P< 0.000	1705.4	1551.1	5798.2
7.	Linearized Growth	-531.2^{***}	0.2^{***}	-	-	R^2= 0.163^{***}	P< 0.000	1705.4	1551.1	5798.2
8.	Linearized S-curve	547.0^{***}	-1086 799^{***}	-	-	R^2= 0.163^{***}	P< 0.000	1705.7	1551.3	5780.5
9.	Exponential Smoothing	0.9	-	-	-	χ^2= 0.38	P< 0.000	339.0	168.7	5173.3

10.	ARIMA (2,1,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.46	P< 0.000 AIC= 1725	314.0	180.8	4279.3

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.17, although many linearized models have significant R^2 values, the ARIMA(2,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1725), as indicated above, among various models fitted apart from lowest error measures like RMSE (314.0), MAE (180.8) and MAPE (4279.3). Thus, ARIMA model is chosen as best model for forecasting of soybean prices in Rajnandgaon market.

4.5.1.4 Forecasting of Arrivals and Prices of Soybean in Rajnandgaon Market

After identification of the model, forecasting of arrivals and prices of soybean has been done. The best ARIMA model has been used to forecast the arrivals and prices of soybean in Rajnandgaon market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.18 and also depitcted in graph in Fig 4.12.

Table 4.18: Forecasted values of Arrivals and Prices of Soybean in Rajnandgaon Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	9026.21	6487.67	4027.78	4054.93
February	7155.82	6502.69	3899.83	4052.21
March	6698.11	6508.67	3849.34	4022.24
April	6581.36	6509.40	3955.69	4054.89
May	6552.79	6509.72	3936.22	4052.18
June	6543.27	6509.13	3896.48	4017.72
July	6541.93	6509.27	3949.43	4040.50
August	6547.28	6510.88	3956.84	4048.60
September	6545.99	6510.55	3921.82	4020.79
October	6463.73	6487.71	3952.66	4029.47
November	6322.99	6448.61	3943.81	4050.73
December	6435.76	6479.94	4008.36	4002.81

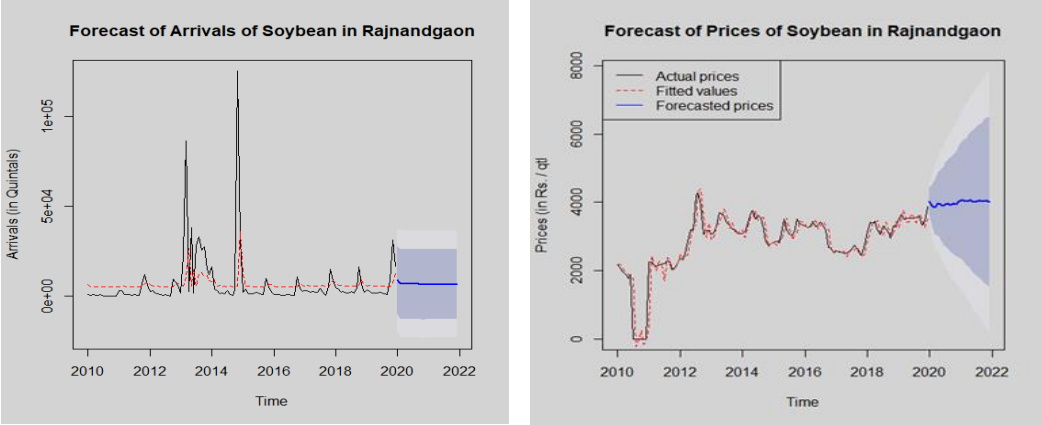

Fig. 4.12: Forecasts of Arrivals and Prices of Soybean in Rajnandgaon Market

From the Table 4.18, the highest forecasted arrivals of soybean for Rajnandgaon are expected to be 9026.21 quintals and 6510.88 quintals respectively in the month of January, 2020 and August, 2021 with respective forcasted prices to be Rs. 4027.78/quintal and Rs. 4048.60/quintal. However, the maximum prices were found to be Rs. 4027.78/quintal in the month of January, 2020 and Rs. 4054.93/quintal in the month of January, 2021.

4.5.2 Linseed

4.5.2.1 Trend in Arrivals and Prices of Linseed in Rajnandgaon Market

Time series data for arrivals of linseed in Rajnandgaon has been presented in Fig. 4.13: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 800 quintals in June 2019 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of linseed have also been plotted over the observed time series.

The linearized trend in the arrivals of linseed in Rajnandgaon has been indicated by dark-green line in the graph shown in Fig. 4.13: (e). It could be seen that the arrivals of linseed in Rajnandgaon had shown an increasing trend in arrivals over the years.

Similarly time series data for prices of linseed in Rajnandgaon has been presented in Fig. 4.13: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs.6339.3 in June 2016 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of linseed have also been plottted.

The linearized trend in the prices of linseed in Rajnandgaon has been indicated by dark-green line in the graph shown there. It could be seen that the prices of linseed in Rajnandgaon had shown an increasing trend over the years.

4.5.2.2 Seasonality pattern in Arrivals and Prices of Linseed in Rajnandgaon Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.13: (g). The seasonal variation has been plotted in the graph of linseed arrivals in Rajnandgaon.

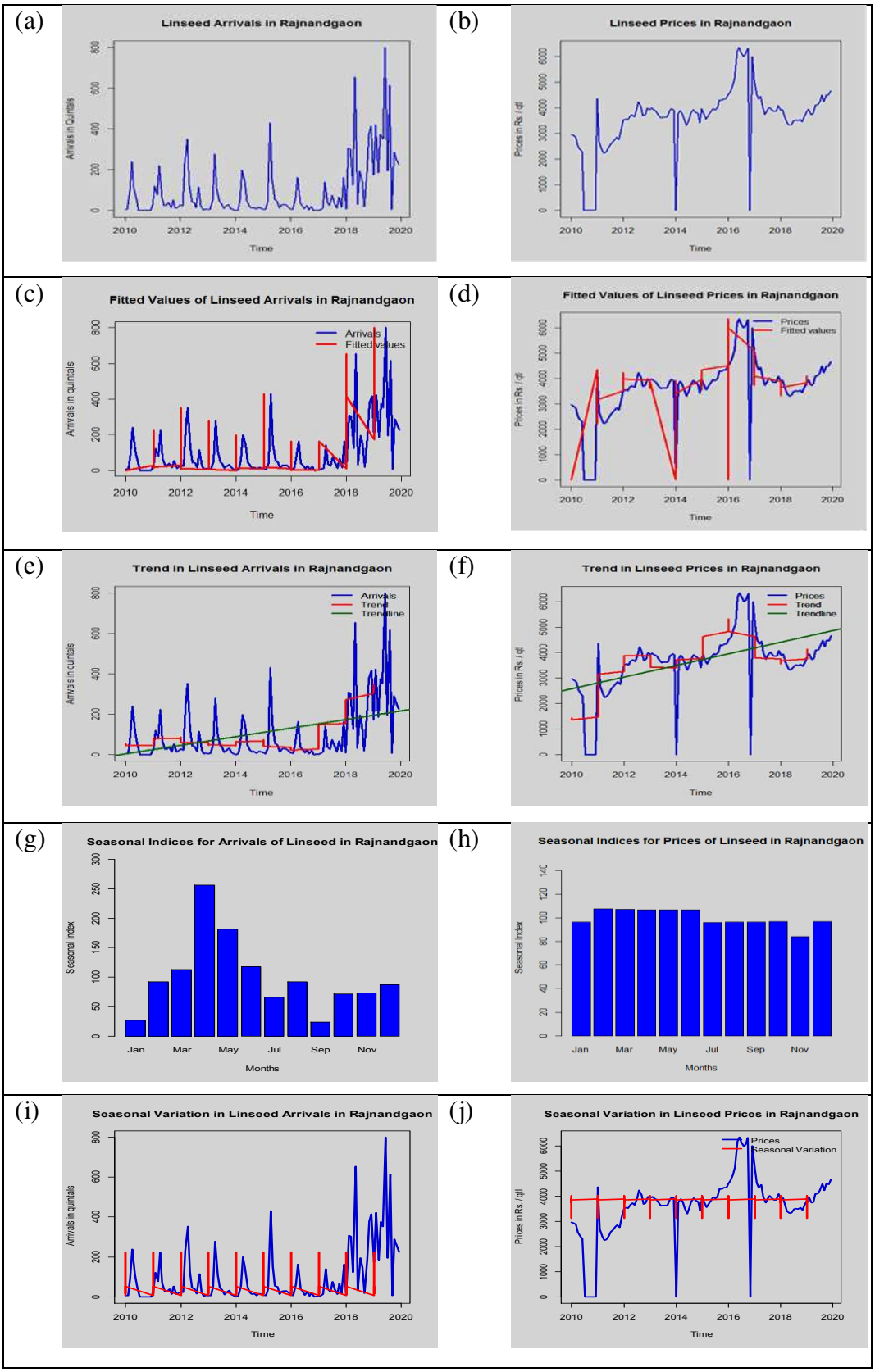

Fig. 4.13: Trend and Seasonality pattern in Arrivals and Prices of Linseed in Rajnandgaon Market

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.13: (h). The seasonal variation has been plotted in the graph of linseed prices in Rajnandgaon.

4.5.2.3 Identifying the Best Forecasting Model for Arrivals and Prices of Linseed in Rajnandgaon Market

By fitting different linear and non-linear time series models, we got following results for arrivals of linseed in Rajnandgaon market were obtained as presented in the Table 4.19.

Table 4.19: Parameters of Fitted Model of Arrivals of Linseed in Rajnandgaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-4291 9.26***	21.3***	-	-	R^2= 0.181***	P< 0.000	131.2	90.1	997.8
	2nd order	2984 7891***	-2965 4.3***	7.3***	-	R^2= 0.319***	P< 0.000	120.1	78.3	1565.5
	3rd order	37.2***	52.9***	-21.3***	2.1***	R^2= 0.387***	P< 0.000	114.5	73.8	918.7
2.	Linearized Compound	5.87 x10^{-209}***	1.2***	-	-	R^2= 0.146***	P< 0.000	146.4	32.2	439.5
3.	Linearized Inverse	430 68.9***	-8656 3854***	-	-	R^2= 0.181***	P< 0.000	131.3	90.2	997.9
4.	Linearized Logarithmic	-327 006***	429 94***	-	-	R^2= 0.181***	P< 0.000	131.2	90.1	997.9
5.	Linearized Power	-	48 2.7***	-	-	R^2= 0.146***	P< 0.000	146.4	82.2	439.5
6.	Linearized Exponential	5.87 x10^{-209}***	0.2***	-	-	R^2= 0.146***	P< 0.000	146.4	82.2	439.5
7.	Linearized Growth	-47 9.4***	0.2***	-	-	R^2= 0.146***	P< 0.000	146.4	82.2	439.5
8.	Linearized S-curve	486***	-972 31.5***	-	-	R^2= 0.146***	P< 0.000	146.4	82.2	439.5
9.	Exponential Smoothing	0.18	-	-	-	χ^2= 47.2	P< 0.000	122.6	76.5	824.9
10.	ARIMA (2,1,1) (1,0,1) [12]	-	-	-	-	χ^2= 0.01	P< 0.000 AIC= 1463.2	104.6	60.6	587.4

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.19, although many linearized models have significant R^2 values, the ARIMA(2,1,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1463.2), as indicated above, among various models fitted apart from lowest error measures like RMSE (104.6), MAE (60.6) and MAPE (587.4). Thus, ARIMA model is chosen as best model for forecasting of linseed arrivals in Rajnandgaon market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of linseed in Rajnandgaon market were obtained as presented in the Table 4.20.

Table 4.20: Parameters of Fitted Model of Prices of Linseed in Rajnandgaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-457304***	228.7***	-	-	R^2= 0.275***	P< 0.000	1074.7	738.7	38198.1
	2nd order	-287605353***	2853 10.6***	-70.7***	-	R^2= 0.444***	P< 0.000	945.3	630.6	31356.9
	3rd order	1509.5***	12 66.6***	-188.1**	8.6$^{\$}$	R^2= 0.459***	P< 0.000	936.6	600.4	28999.0
2.	Linearized Compound	3.85 x10$^{-234***}$	1.31***	-	-	R^2= 0.120***	P< 0.000	2131.3	1974.9	41465.0
3.	Linearized Inverse	464 970.4***	-92941 3812***	-	-	R^2= 0.275***	P< 0.000	1074.5	738.5	38177.4
4.	Linearized Logarithmic	-350 4782***	4611 37.2***	-	-	R^2= 0.120***	P< 0.000	2131.0	1974.7	38187.8
5.	Linearized Power	-	545.3***	-	-	R^2= 0.120***	P< 0.000	2131.3	1974.9	41460.6
6.	Linearized Exponential	3.83 x10$^{-234***}$	0.2***	-	-	R^2= 0.120***	P< 0.000	2131.3	1974.9	41465.0
7.	Linearized Growth	-537.4***	0.2***	-	-	R^2= 0.120***	P< 0.000	2130.7	1974.4	41465.0
8.	Linearized S-curve	553.3***	-109 9286***	-	-	R^2= 0.120***	P< 0.000	2130.7	1974.4	41456.3
9.	Exponential Smoothing	0.31		-	-	χ^2= 0.01	P< .000	909.5	424.0	27332.7
10.	ARIMA (2,1,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.02	P< 0.000 AIC= 1971.4	896.1	444.9	26493.8

Note:- Polynomial models upto 3rd order are significant.

Notations:-

* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.20, although many linearized models have significant R^2 values, the ARIMA(1,1,1) model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1971.4), as indicated above, among various models fitted apart from lowest error measures like RMSE (896.1), MAE (444.9) and MAPE (26493.8). Thus, ARIMA model is chosen as best model for forecasting of linseed prices in Rajnandgaon market.

4.5.2.4 Forecasting of Arrivals and Prices of Linseed in Rajnandgaon Market

After identification of the model, forecasting of arrivals and prices of linseed has been done. The best ARIMA model has been used to forecast the arrivals and prices of linseed in Rajnandgaon market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.21 and also depitcted in graph in Fig. 4.14.

Table 4.21: Forecasted values of Arrivals and Prices of linseed in Rajnandgaon Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	241.00	299.87	4440.20	4235.27
February	338.96	396.92	4426.25	4226.70
March	309.15	351.00	4389.87	4218.57
April	352.95	394.53	4363.49	4211.49
May	425.44	446.95	4345.83	4205.36
June	457.17	476.34	4324.67	4199.76
July	296.52	340.48	4308.22	4194.85
August	418.37	442.70	4296.20	4190.55
September	200.18	260.94	4276.33	4186.48
October	323.04	363.22	4267.89	4183.12
November	337.69	374.96	4255.69	4180.00
December	346.93	382.83	4248.70	4177.33

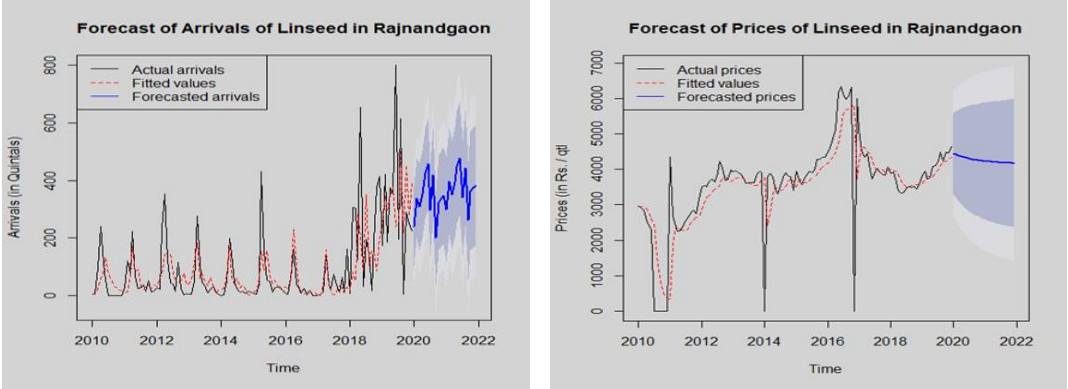

Fig. 4.14: Forecasts of Arrivals and Prices of Linseed in Rajnandgaon Market

From the Table 4.21, the highest forecasted arrivals of linseed for Rajnandgaon are expected to be 457.17 quintals and 476.34 quintals respectively in the month of June, 2020 and June, 2021 with respective forcasted prices to be Rs. 4324.67/quintal and Rs. 4199.76/quintal. However, the maximum prices were found to be Rs. 4440.20/quintal in the month of January, 2020 and Rs. 4235.27/quintal in the month of January, 2021.

4.5.3 Mustard

4.5.3.1 Trend in Arrivals and Prices of Mustard in Rajnandgaon Market

Time series data for arrivals of mustard in Rajnandgaon has been presented in Fig. 4.15: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 1634 quintals in April 2019 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of mustard have also been plotted over the observed time series.

The linearized trend in the arrivals of mustard in Rajnandgaon has been indicated by dark-green line in the graph shown in Fig. 4.15: (e). It could be seen that the arrivals of mustard in Rajnandgaon had shown an increasing trend in arrivals over the years.

Similarly time series data for prices of mustard in Rajnandgaon has been presented in Fig. 4.15: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4135.38 in November 2015 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of mustard have also been plottted.

The linearized trend in the prices of mustard in Rajnandgaon has been indicated by dark-green line in the graph shown in Fig. 4.15: (f). It could be seen that the prices of mustard in Rajnandgaon had shown an increasing trend over the years.

4.5.3.2 Seasonality pattern in Arrivals and Prices of Mustard in Rajnandgaon Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.15: (g). The seasonal variation has been plotted in the graph of mustard arrivals in Rajnandgaon.

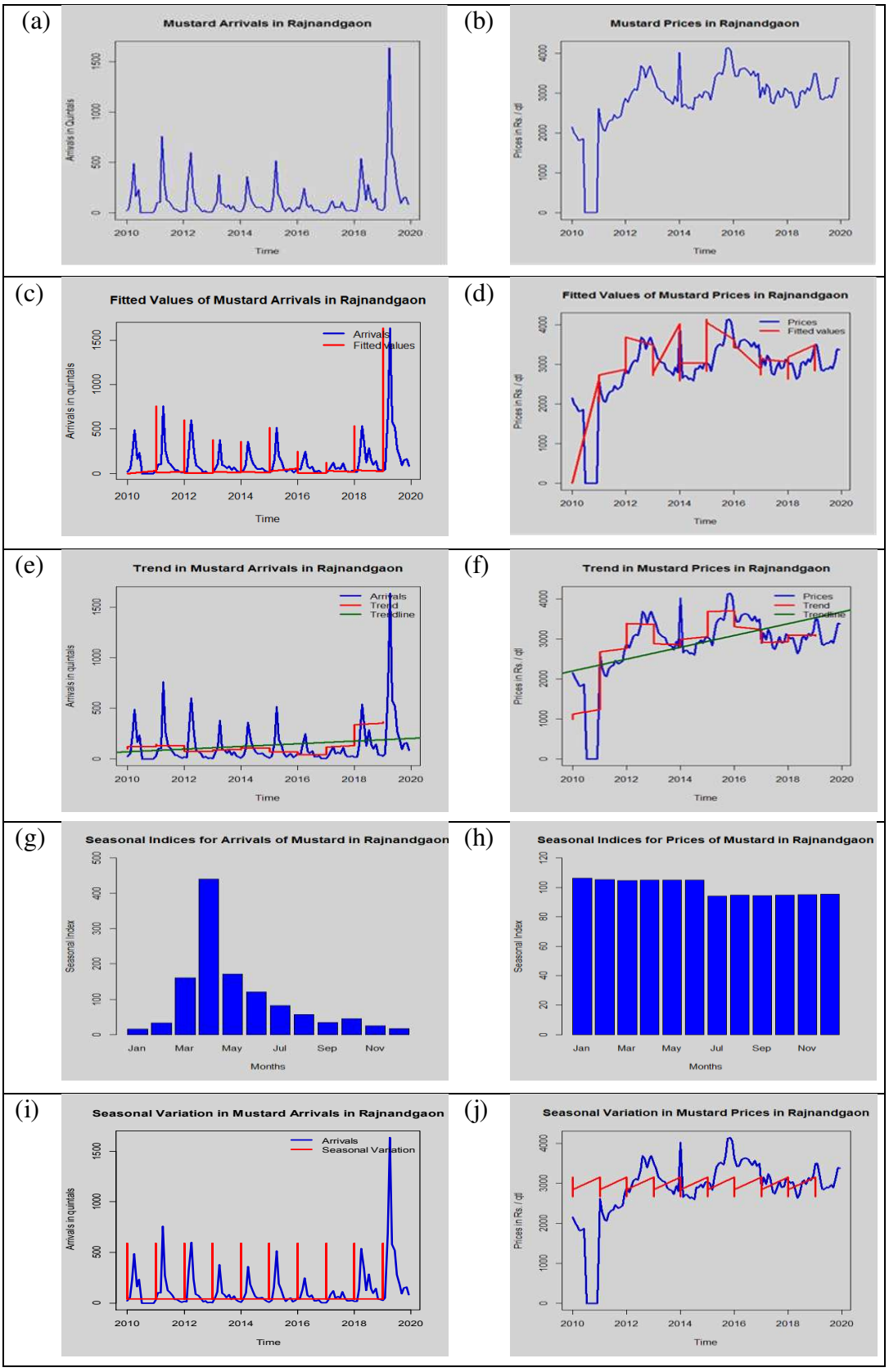

Fig. 4.15: Trend and Seasonality pattern in Arrivals and Prices of Mustard in Rajnandgaon Market

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.15: (h). The seasonal variation has been plotted in the graph of mustard prices in Rajnandgaon.

4.5.3.3 Identifying the Best Forecasting Model for Arrivals and Prices of Mustard in Rajnandgaon Market

By fitting different linear and non-linear time series models, we got following results for arrivals of mustard in Rajnandgaon market were obtained as presented in the Table 4.22.

Table 4.22: Parameters of Fitted Model of Arrivals of Mustard in Rajnandgaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-26620*	13.2*	-	-	R^2= 0.034*	P= 0.041	202.9	120.1	1125.0
	2nd order	31004278**	-30794.3**	7.6**	-	R^2= 0.108**	P= 0.001	195.8	115.1	1194.5
	3rd order	91.7$	69.4NS	-28.9*	2.7**	R^2= 0.162***	P< 0.000	190.6	112.8	1224.5
2.	Linearized Compound	4.65 x10-154***	19***	-	-	R^2= 0.096***	P= 0.000	214.1	102.7	402.8
3.	Linearized Inverse	26827.1*	-53785252*	-	-	R^2= 0.034*	P= 0.041	202.9	120.1	1125.4
4.	Linearized Logarithmic	-203188.4*	26723.5*	-	-	R^2= 0.034*	P= 0.041	202.9	120.1	1125.2
5.	Linearized Power	-	356.95***	-	-	R^2= 0.096***	P= 0.000	214.1	102.7	402.7
6.	Linearized Exponential	4.65 x10-154***	0.17***	-	-	R^2= 0.096***	P= 0.000	214.1	102.7	402.8
7.	Linearized Growth	-353***	0.17***	-	-	R^2= 0.096***	P= 0.000	214.1	102.7	402.8
8.	Linearized S-curve	360.8***	-719072.1***	-	-	R^2= 0,096***	P= 0.000	214.1	102.7	402.6
9.	Exponential Smoothing	0.72	-	-	-	χ^2= 45.20	P= 0.000	195.3	105.4	635.0
10.	ARIMA (1,1,1) (0,1,0) [12]	-	-	-	-	χ^2= 0.12	P< 0.000 AIC =1521.4	127.2	62.7	81.2

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.22, although many linearized models have significant R^2 values, the ARIMA(1,1,1)(0,1,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1521.4), as indicated above, among various models fitted apart from lowest error measures like RMSE (127.2), MAE (62.7) and MAPE (81.2). Thus, ARIMA model is chosen as best model for forecasting of mustard arrivals in Rajnandgaon market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of mustard in Rajnandgaon market were obtained as presented in the Table 4.23.

Table 4.23 Parameters of Fitted Model of Prices of Mustard in Rajnandgaon

S. N.	Models	α	β_1	β_2	β_3	β_4	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial										
	1st order	-2948 53.8***	147.7***	-	-	-	R^2= 0.276***	P< 0.000	692.7	483.2	21933.1
	2nd order	-25031 6247***	2483 70.1***	-6 1.6***	-	-	R^2= 0.583***	P< 0.000	527.7	388.8	14538.8
	3rd order	112 0.7***	1309.8***	-23 9.5***	13.1***	-	R^2= 0.665***	P< 0.000	474.7	364.1	11217.7
	4th order	102 1.2***	1724.2***	-47 2***	54.6***	-2***	R^2= 0.677***	P< 0.000	467.1	358.1	10223.1
2.	Linearized Compound	4.03x 10^{-227}***	1.3***	-	-	-	R^2= 0.157***	P< 0.000	1738	1569.1	5946.0
3.	Linearized Inverse	3009 61***	-6005 30399***	-	-	-	R^2= 0.277***	P< 0.000	692.4	483.0	21915.4
4.	Linearized Log-arithmic	-22636 662***	297 907.7***	-	-	-	R^2= 0.277***	P< 0.000	392.5	483.1	21924.2
5.	Linearized Power	-	529.1***	-	-	-	R^2= 0.157***	P< 0.000	1739	1569.2	5936.8
6.	Linearized Exponen-tial	4.03x 10^{-227}***	0.2***	-	-	-	R^2= 0.157***	< 0.000	1738	1569.1	5946.0
7.	Linearized Growth	-52 1.2***	0.2***	-	-	-	R^2= 0.157***	P< 0.000	1738	1569.1	5946.0
8.	Linearized S-curve	537.1***	-1066 769***	-	-	-	R^2= 0.157***	P< 0.000	1739	1569.2	5927.6
9.	Exponen-tial Smoothing	0.8	-	-	-	-	χ^2= 0.001	P= 0.000	374.0	186.2	4752.1
10.	ARIMA (2,1,2) (1,0,1) [12]	-	-	-	-	-	χ^2= 0.007	P< 0.000 AIC =1754	358.2	196.3	4638.4
Note:- Polynomial models upto 3rd order are significant.											

Notations:-	
*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.23, although many linearized models have significant R^2 values, the ARIMA(2,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1754), as indicated above, among various models fitted apart from lowest error measures like RMSE (358.2), MAE (196.3) and MAPE (4638.4). Thus, ARIMA model is chosen as best model for forecasting of mustard prices in Rajnandgaon market.

4.5.3.4 Forecasting of Arrivals and Prices of Mustard in Rajnandgaon Market

After identification of the model, forecasting of arrivals and prices of mustard has been done. The best ARIMA model has been used to forecast the arrivals and prices of mustard in Rajnandgaon market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.24 and also depitcted in graph in Fig 4.16.

Table 4.24: Forecasted values of Arrivals and Prices of Mustard in Rajnandgaon Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	119.09	239.79	3354.42	3285.22
February	161.07	281.77	3463.51	3195.58
March	804.60	925.30	3299.46	3265.41
April	1753.12	1873.82	3291.61	3249.53
May	698.09	818.79	3309.36	3222.14
June	638.46	759.16	3254.36	3237.58
July	398.61	519.31	3204.09	3252.32
August	300.66	421.36	3193.94	3246.24
September	212.68	333.38	3227.45	3217.18
October	269.69	390.39	3233.29	3204.89
November	278.69	399.39	3329.12	3143.31
December	203.69	324.39	3299.26	3153.13

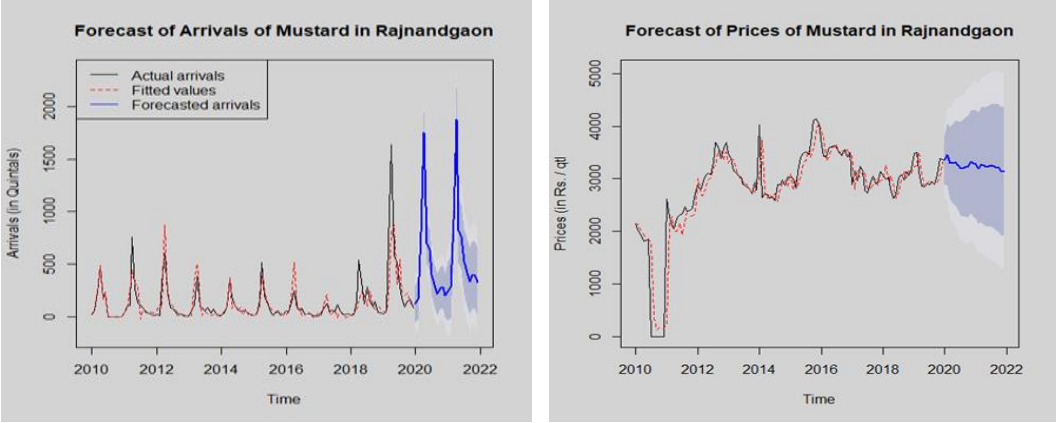

Fig. 4.16: Forecasts of Arrivals and Prices of Mustard in Rajnandgaon Market

From the Table 4.24, the highest forecasted arrivals of linseed for Rajnandgaon are expected to be 1753.12 quintals and 1873.82 quintals respectively in the month of April, 2020 and April, 2021 with respective forcasted prices to be Rs. 3291.61/quintal and Rs. 3249.53/quintal. However, the maximum prices were found to be Rs. 3463.51/quintal in the month of February, 2020 and Rs. 3285.22/quintal in the month of January, 2021.

4.6 Results for Arrivals and Prices of Oilseeds in Khairagarh Market

4.6.1 Soybean

4.6.1.1 Trend in Arrivals and Prices of Soybean in Khairagarh Market

Time series data for arrivals of soybean in Khairagarh has been presented in Fig. 4.17: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 27488 quintals in November 2013 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of soybean has been plotted there.

The linearized trend in the arrivals of soybean in Khairagarh has been indicated by dark-green line in the graph shown in Fig. 4.17: (e). It could be seen that the arrivals of soybean in Khairagarh had shown a decreasing trend over the years.

Similarly time series data for prices of soybean in Khairagarh has been presented in Fig. 4.17: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 7233.33 in October 2012 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of soybean have also been plottted.

The linearized trend in the prices of soybean in Khairagarh has been indicated by dark-green line in the graph shown in Fig. 4.17: (f). It could be seen that the prices of soybean in Khairagarh had shown a decreasing trend over the years.

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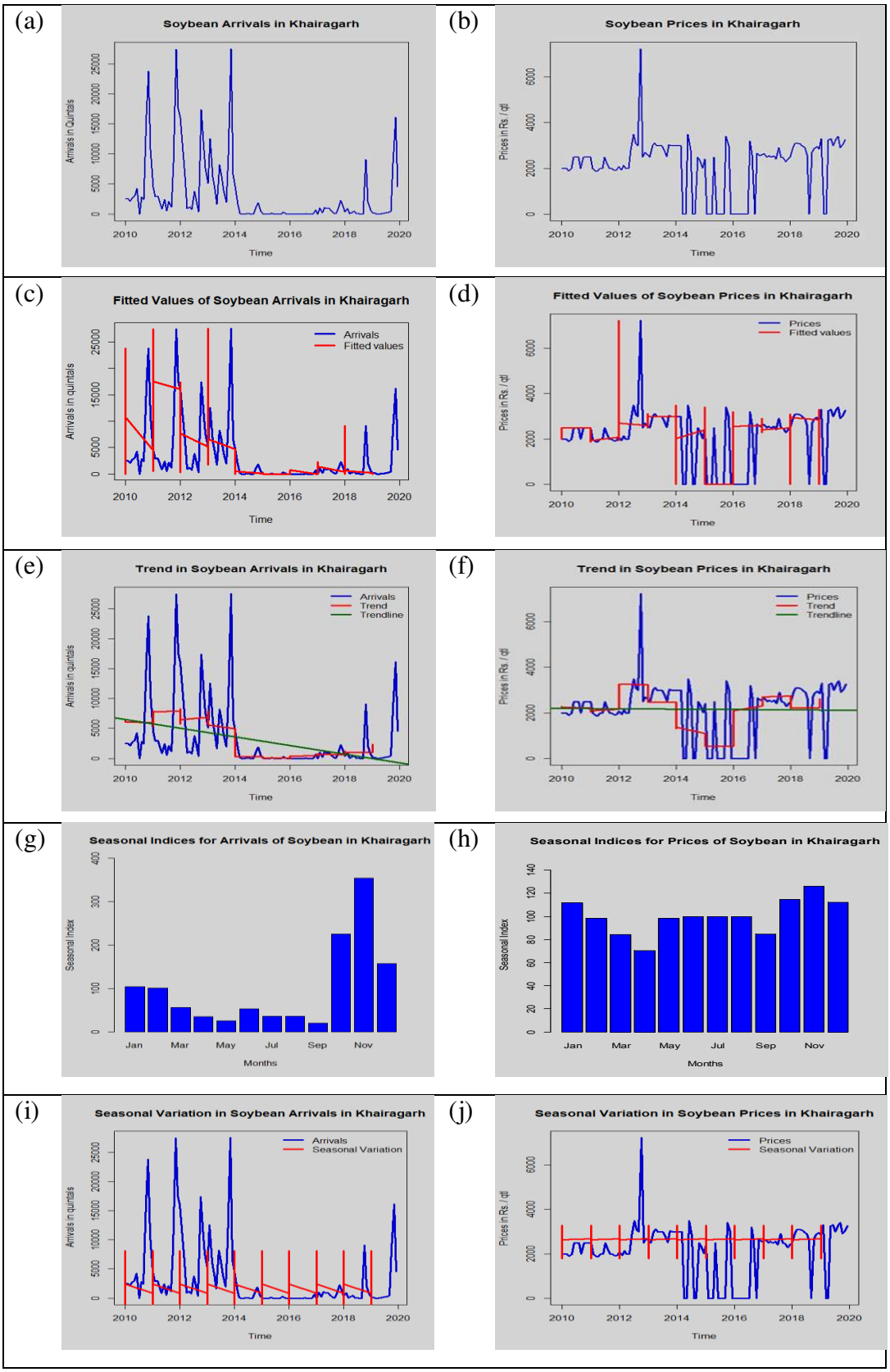


Fig. 4.17: Trend and Seasonality pattern in Arrivals and Prices of Soybean in Khairagarh Market

4.6.1.2 Seasonality pattern in Arrivals and Prices of Soybean in Khairagarh Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.17: (g). The seasonal variation has been plotted in the graph of soybean arrivals in Khairagarh.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.17: (h). The seasonal variation has been plotted in the graph of soybean prices in Khairagarh.

4.6.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Soybean in Khairagarh Market

By fitting different linear and non-linear time series models, we got following results for arrivals of soybean in Khairagarh market were obtained as presented in the Table 4.25.

Table 4.25: Parameters of Fitted Model of Arrivals of Soybean in Khairagarh

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	1460069***	-723.1***	-	-	R^2= 0.141***	P< 0.000	5154.7	3313.1	111858.0
	2nd order	491475663$	-487212.7$	120.7$	-	R^2= 0.167***	P< 0.000	5099.9	3252.8	87823.9
	3rd order	6084.0***	1515.4NS	-853*	72.1**	R^2= 0.219***	P< 0.000	4956.8	3113.5	62666.4
2.	Linearized Compound	0***	0.60***	-	-	R^2= 0.159***	P< 0.000	6009.1	2865.3	94204.0
3.	Linearized Inverse	-1454439***	2936404515***	-	-	R^2= 0.141***	P< 0.000	5154.3	3312.4	111752.1
4.	Linearized Logarithmic	11090171***	-1457254***	-	-	R^2= 0.141***	P< 0.000	5154.5	3312.7	111805.0
5.	Linearized Power	-	-1027***	-	-	R^2= 0.159***	P< 0.000	6008.6	2864.7	94236.0
6.	Linearized Exponential	0***	-0.50***	-	-	R^2= 0.159***	P< 0.000	6009.1	2865.3	94204.0
7.	Linearized Growth	1031.8***	-0.50***	-	-	R^2= 0.159***	P< 0.000	6009.1	2865.3	94204.0
8.	Linearized S-curve	-1022***	2070018***	-	-	R^2= 0.160***	P< 0.000	6008.1	2864.1	94268.0
9.	Exponential Smoothing	0.72	-	-	-	χ^2= 53.15	P< 0.000	4812.0	2521.4	41081.3

10.	ARIMA (1,1,1) (2,0,0) [12]	-	-	-	-	χ^2= 0.001	P< 0.000 AIC= 2316.3	3782.6	2183.1	37141.8
Note:- Polynomial models upto 3rd order are significant.										
Notations:-										
* Significant at 5% level of Significance										
** Significant at 1% level of Significance										
*** Significant at 0.1% level of Significance										
$ Significant at 10% level of Significance										

From the Table 4.25, although many linearized models have significant R^2 values, the ARIMA(1,1,1)(2,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2316.3), as indicated above, among various models fitted apart from lowest error measures like RMSE (3782.6), MAE (2183.1) and MAPE (37141.8). Thus, ARIMA model is chosen as best model for forecasting of soybean arrivals in Khairagarh market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of soybean in Khairagarh market were obtained as presented in the Table 4.26.

Table 4.26: Parameters of Fitted Model of Prices of Soybean in Khairagarh

S. N.	**Models**	**α**	**β_1**	**β_2**	**β_3**	**R^2 / Test-Statistics**	**P-value / AIC**	**RMSE**	**MAE**	**MAPE**
1.	Linearized Polynomial 1st order	171 15.9^{NS}	-7.4^{NS}	-	-	R^2= 0.000^{NS}	P= 0.847	1208.8	896.1	82514.8
	2nd order	16430 3227**	-1631 11.4**	40.4**	-	R^2= 0.060**	P= 0.020	1176.8	901.7	74690.4
	3rd order	2220.2**	469.1^{NS}	-205.7*	18.24**	R^2= 0.132***	P= 0.000	1136.1	861.5	70567.8
2.	Linearized Compound	1.41x $10^{179\$}$	0.81$^{\$}$	-	-	R^2= 0.029$^{\$}$	P= 0.060	2002.9	1753.2	15994.9
3.	Linearized Inverse	-1305 3.2^{NS}	3064 8424^{NS}	-	-	R^2= 0.000^{NS}	P= 0.844	1208.8	896.2	82508.4
4.	Linearized Logarithmic	1169 26.6^{NS}	-150 94.6^{NS}	-	-	R^2= 0.000^{NS}	P= 0.844	1208.8	896.2	82511.6
5.	Linearized Power	-	-406.7$^{\$}$	-	-	R^2= 0.029$^{\$}$	P= 0.060	2002.8	1752.8	15986.7
6.	Linearized Exponential	1.41 x$10^{179\$}$	-0.2$^{\$}$	-	-	R^2= 0.029$^{\$}$	P= 0.060	2002.9	1753.2	15994.9
7.	Linearized Growth	412.5$^{\$}$	-0.2$^{\$}$	-	-	R^2= 0.029$^{\$}$	P= 0.060	2002.9	1753.2	15994.9
8.	Linearized S-curve	-401$^{\$}$	8204 28.6$^{\$}$	-	-	R^2= 0.029$^{\$}$	P= 0.060	2002.6	1752.5	15978.5

9.	Exponential Smoothing	0.24	-	-	-	χ^2= 3.42	P< 0.000	1071.6	701.1	14251.3
10.	ARIMA (1,0,3) (1,0,1) [12]	-	-	-	-	χ^2= 0.036	P< 0.000 AIC= 2014.8	996.2	664.6	14150.3

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.26, although many linearized models have significant R^2 values, the ARIMA(1,0,3)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2014.8), as indicated above, among various models fitted apart from lowest error measures like RMSE (996.2), MAE (664.6) and MAPE (14150.3). Thus, ARIMA model is chosen as best model for forecasting of soybean prices in Khairagarh market.

4.6.1.4 Forecasting of Arrivals and Prices of Soybean in Khairagarh Market

After identification of the model, forecasting of arrivals and prices of soybean has been done. The best ARIMA model has been used to forecast the arrivals and prices of soybean in Khairagarh market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.27 and also depitcted in graph in Fig. 18.

Table4.27: Forecasted values of Arrivals and Prices of Soybean in Khairagarh

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	2743.39	2083.32	2923.98	2319.98
February	2288.91	1939.98	2757.94	2379.50
March	1611.45	1699.12	2513.49	2560.76
April	1526.62	1675.47	2590.80	2446.12
May	1492.73	1671.56	2876.32	2165.63
June	1346.32	1662.25	2592.79	2354.43
July	1347.39	1700.66	2556.12	2345.07
August	1354.44	1749.62	2539.58	2322.62
September	1380.24	1800.10	2684.57	2171.16
October	6963.03	6310.40	2525.74	2270.94
November	6510.15	9035.44	2480.60	2280.33
December	2765.40	3703.77	2362.28	2351.90

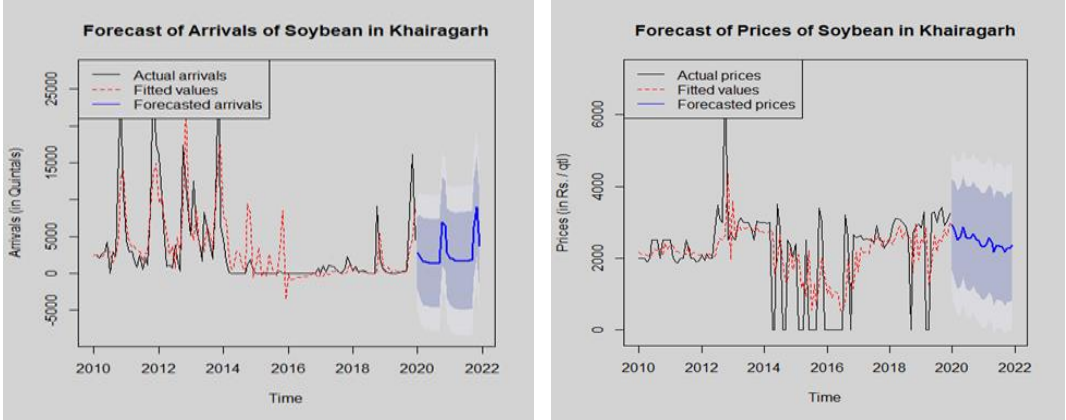


Fig. 4.18: Forecasts of Arrivals and Prices of Soybean in Khairagarh market

From the Table 4.27, the highest forecasted arrivals of soybean for Khairagarh are expected to be 6963.03 quintals and 9035.44 quintals respectively in the month of October, 2020 and November, 2021 with respective forcasted prices to be Rs. 2525.74/quintal and Rs. 2280.33/quintal. However, the maximum prices were found to be Rs. 2923.98/quintal in the month of January, 2020 and Rs. 2560.76/quintal in the month of March, 2021.

4.7 Results for Arrivals and Prices of Oilseeds in Gandai Market

4.7.1 Soybean

4.7.1.1 Trend in Arrivals and Prices of Soybean in Gandai Market

Time series data for arrivals of soybean in Gandai has been presented in Fig. 4.19: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 144225.15 quintals in November 2011 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of soybean have also been plotted over the observed time series.

The linearized trend in the arrivals of soybean in Gandai has been indicated by dark-green line in the graph shown in Fig.4.19: (e). It could be seen that the arrivals of soybean in Gandai had shown a decreasing trend in arrivals over the years.

Similarly time series data for prices of soybean in Gandai has been presented in Fig. 4.19: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 3450 in February 2018 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of soybean have also been plottted.

The linearized trend in the prices of soybean in Gandai has been indicated by dark-green line in the graph shown in Fig. 4.19: (f). It could be seen that the prices of soybean in Gandai had shown an increasing trend over the years.

4.7.1.2 Seasonality pattern in Arrivals and Prices of Soybean in Gandai Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices

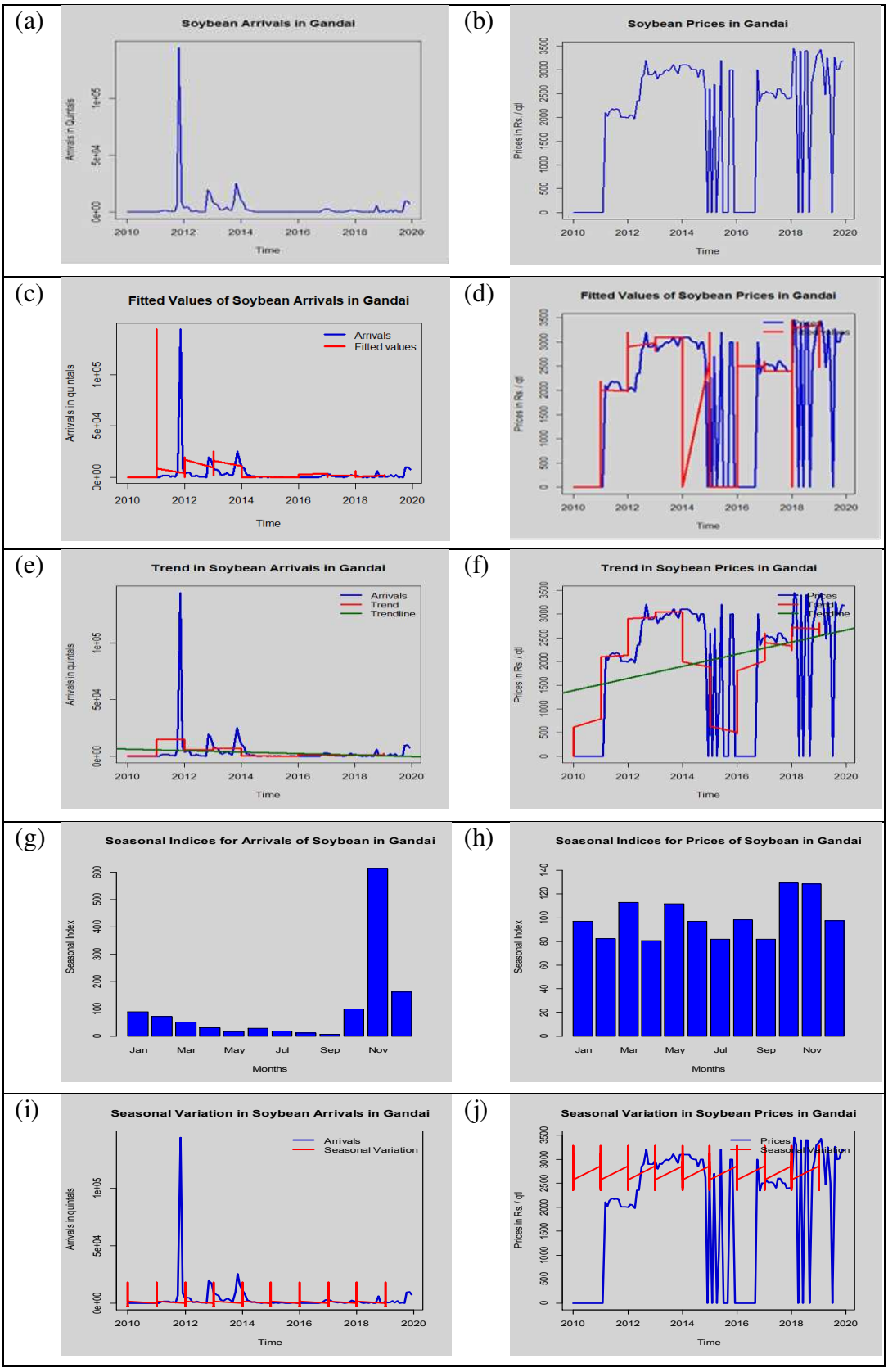


Fig. 4.19: Trend and Seasonality pattern in Arrivals and Prices of Soybean in Gandai Market

has been shown in Fig. 4.19: (g). The seasonal variation has been plotted in the graph of soybean arrivals in Gandai.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.19: (h). The seasonal variation has been plotted in the graph of soybean prices in Gandai.

4.7.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Soybean in Gandai Market

By fitting different linear and non-linear time series models, we got following results for arrivals of soybean in Gandai market were obtained as presented in the Table 4.28.

Table 4.28: Parameters of Fitted Model of Arrivals of Soybean in Gandai Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	1295 252^{NS}	-6 41.3^{NS}	-	-	R^2= 0.018^{NS}	P= 0.139	13548.6	4447.2	221949.7
	2nd order	12705 2501^{NS}	-1254 93.6^{NS}	30.9^{NS}	-	R^2= 0.018^{NS}	P= 0.330	13604.5	4430.9	225602.7
	3rd order	3343.4^{NS}	49 73.1^{NS}	-16 94.8$^{\$}$	127.8$^{\$}$	R^2= 0.046^{NS}	P= 0.138	13470.5	4381.2	126840.8
2.	Linearized Compound	1.11 x10$^{-87\ NS}$	1.1^{NS}	-	-	R^2= 0.005^{NS}	P= 0.401	14053.2	3319.1	64040.6
3.	Linearized Inverse	-1288 829^{NS}	26030 03291^{NS}	-	-	R^2= 0.018^{NS}	P= 0.139	13548.6	4447.1	221991.6
4.	Linearized Logarithmic	983 3315^{NS}	-1292 041^{NS}	-	-	R^2= 0.018^{NS}	P= 0.139	13548.6	4447.1	221970.6
5.	Linearized Power	-	205.1^{NS}	-	-	R^2= 0.005^{NS}	P= 0.401	14053.2	3319.1	64041.0
6.	Linearized Exponential	1.11 x10$^{-87\ NS}$	0.01^{NS}	-	-	R^2= 0.005^{NS}	P= 0.401	14053.2	3319.1	64040.0
7.	Linearized Growth	-200.2^{NS}	0.10^{NS}	-	-	R^2= 0.005^{NS}	P= 0.401	14053.1	3319.1	64040.0
8.	Linearized S-curve	210.1^{NS}	-4138 60.8^{NS}	-	-	R^2= 0.006^{NS}	P= 0.400	14053.2	3319.1	64042.0
9.	Exponential Smoothing	0.04	-	-	-	χ^2= 1.29	P< 0.000	13776.9	3948.7	60293.6
10.	ARIMA (2,0,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.64	P< 0.000 AIC= 2635.6	13264.8	4027.2	18938.6

Note:-None of the Polynomial model is significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.28, although many linearized models have significant R^2 values, the ARIMA(2,0,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2635.6), as indicated above, among various models fitted apart from lowest error measures like RMSE (13264.8), MAE (4027.2) and MAPE (18938.6). Thus, ARIMA model is chosen as best model for forecasting of soybean arrivals in Gandai market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of soybean in Gandai market were obtained as presented in the Table 4.29.

Table 4.29: Parameters of Fitted Model of Prices of Soybean in Gandai Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-2547 82.3**	127.4**	-	-	R^2= 0.080**	P= 0.001	1248.5	1065.5	104797.1
	2nd order	-10750 2455$	106 603.4$	-26.4$	-	R^2= 0.102$	P= 0.001	1238.7	1038.1	101889.8
	3rd order	92.1***	2155.7***	-550.7***	38.8***	R^2= 0.382***	P< 0.000	1032.3	787.6	70233.9
2.	Linearized Compound	4.44 x10^{-241}*	1.31*	-	-	R^2= 0.042*	P= 0.024	2082.8	1818.9	14630.9
3.	Linearized Inverse	2588 74.3***	-51754 9884***	-	-	R^2= 0.080***	P= 0.001	1248.5	1065.2	104785.9
4.	Linearized Logarithmic	-1952 020***	256 828.2***	-	-	R^2= 0.080***	P= 0.001	1248.5	1065.3	104791.5
5.	Linearized Power	-	559.1*	-	-	R^2= 0.042*	P= 0.024	2082.8	1818.9	146343.0
6.	Linearized Exponential	4.44 x10^{-241}*	0.27*	-	-	R^2= 0.042*	P= 0.024	2082.8	1818.9	146309.0
7.	Linearized Growth	-553.4*	0.27*	-	-	R^2= 0.042*	P= 0.024	2082.8	1818.9	146309.0
8.	Linearized S-curve	564.9*	-11 2037*	-	-	R^2= 0.042*	P= 0.024	2082.7	1818.9	146378.0
9.	Exponential Smoothing	0.32	-	-	-	χ^2= 0.60	P< 0.000	960.3	577.6	45856.5
10.	ARIMA (2,1,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.01	P< 0.000 AIC= 1983.4	942.5	560.5	44176.1

Note:- Polynomial models upto 3rd order are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.29, although many linearized models have significant R^2 values, the ARIMA(2,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1983.4), as indicated above, among various models fitted apart from lowest error measures like RMSE (942.5), MAE (560.5) and MAPE (44176.1). Thus, ARIMA model is chosen as best model for forecasting of soybean prices in Gandai market.

4.7.1.4 Forecasting of Arrivals and Prices of Soybean in Gandai Market

After identification of the model, forecasting of arrivals and prices of linseed has been done. The best ARIMA model has been used to forecast the arrivals and prices of linseed in Bandhabajar market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.30 and also depitcted in graph in Fig 4.20.

Table 4.30: Forecasted values of Arrivals and Prices of Soybean in Gandai Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	3825.07	2442.83	3126.61	3100.82
February	3516.67	2298.57	3137.86	3104.51
March	3350.15	2321.01	3096.68	3106.61
April	3332.74	2504.44	3091.87	3106.88
May	2859.32	2435.82	3118.47	3105.96
June	2927.99	2756.28	3095.25	3106.78
July	2446.36	2727.44	2680.35	3121.46
August	2226.49	2865.97	3120.92	3105.88
September	1995.90	2974.53	3162.73	3104.40
October	3736.85	4343.98	3098.27	3106.68
November	3492.80	4353.45	3119.88	3105.91
December	2932.64	4093.78	3109.45	3106.28

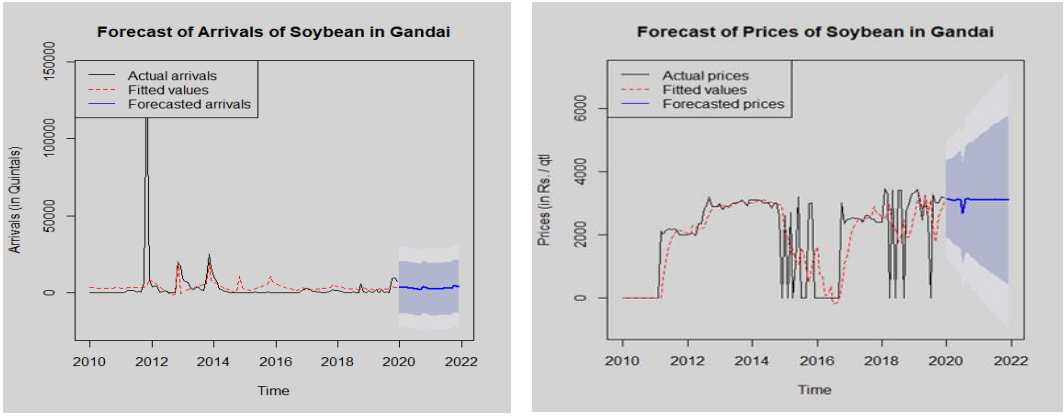


Fig. 4.20: Forecasts of Arrivals and Prices of Soybean in Gandai Market

From the Table 4.30, the highest forecasted arrivals of soybean for Gandai are expected to be 3825.07 quintals and 4353.45 quintals respectively in the month of January, 2020 and November, 2021 with respective forcasted prices to be Rs. 3126.61/quintal and Rs. 3105.91/quintal. However, the maximum prices were found to be Rs. 3162.73/quintal in the month of September, 2020 and Rs. 3121.46/quintal in the month of July, 2021.

4.8 Results for Arrivals and Prices of Oilseeds in Dongargaon Market

4.8.1 Soybean

4.8.1.1 Trend in Arrivals and Prices of Soybean in Dongargaon Market

Time series data for arrivals of soybean in Dongargaon has been presented in Fig. 4.21: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 277838 quintals in March 2017 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of soybean have also been plotted over the observed time series.

The linearized trend in the arrivals of soybean in Dongargaon has been indicated by dark-green line in the graph shown in Fig. 4.21: (e). It could be seen that the arrivals of soybean in Dongargaon had shown an increasing trend in arrivals over the years.

Similarly time series data for prices of soybean in Dongargaon has been presented in there. The maximum price observed was Rs. 3822.96 in December 2018 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of soybean have also been plottted.

The linearized trend in the prices of soybean in Dongargaon has been indicated by dark-green line in the graph shown in Fig. 4.21: (f). It could be seen that the prices of soybean in Dongargaon had shown an increasing trend over the years.

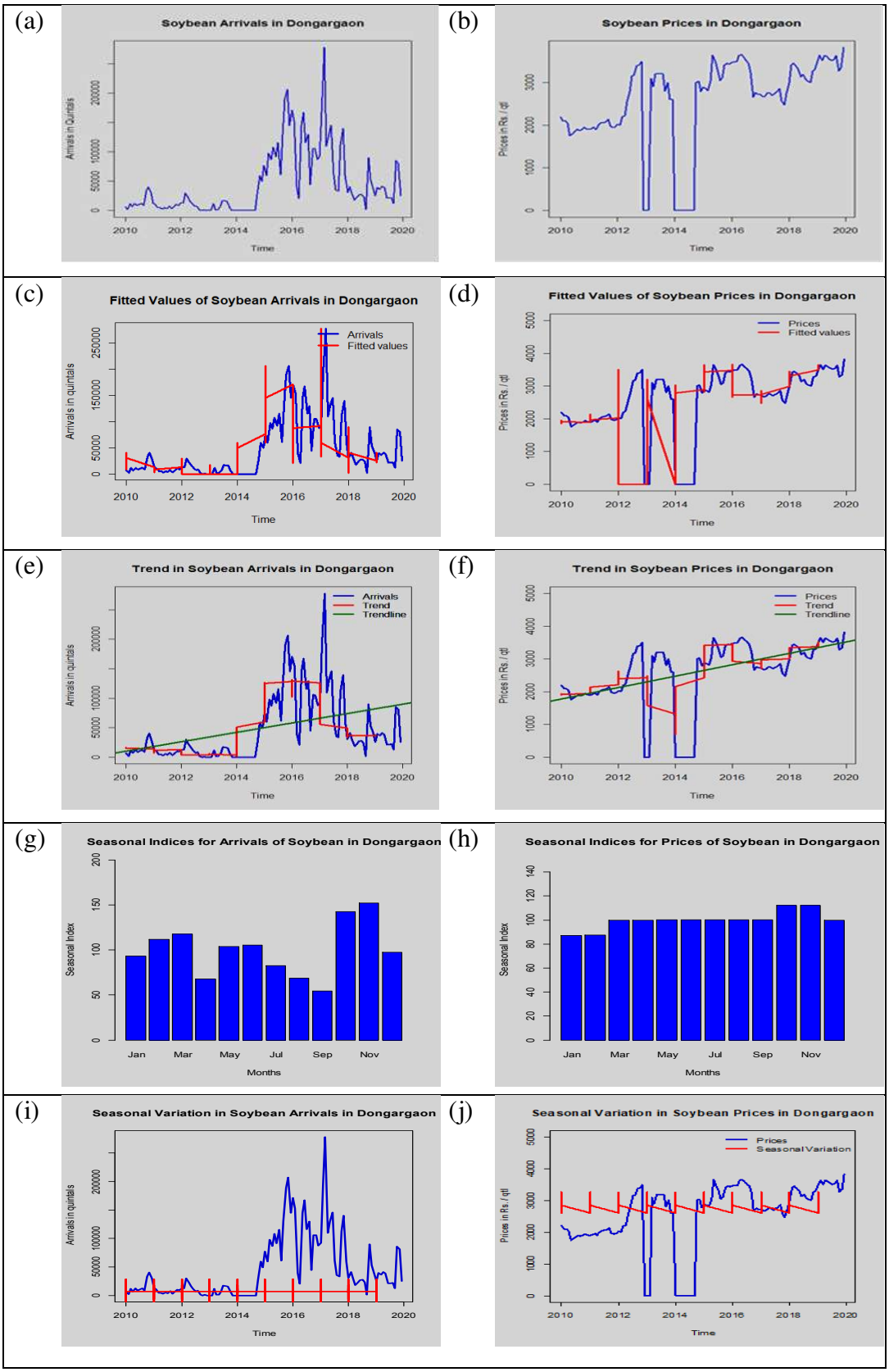


Fig. 4.21: Trend and Seasonality pattern in Arrivals and Prices of Soybean in Dongargaon Market

4.8.1.2 Seasonality pattern in Arrivals and Prices of Soybean in Dongargaon Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.21: (g). The seasonal variation has been plotted in the graph of soybean arrivals in Dongargaon.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.21: (h). The seasonal variation has been plotted in the graph of soybean prices in Dongargaon.

4.8.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Soybean in Dongargaon Market

By fitting different linear and non-linear time series models, we got following results for arrivals of soybean in Dongargaon market were obtained as presented in the Table 4.31.

Table 4.31: Parameters of Fitted Model of Arrivals of Soybean in Dongargaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-16075 850***	80 02.8***	-	-	R^2= 0.173***	P< 0.000	50609.2	37257.7	784881.5
	2nd order	-87 8491 2680***	871 3741***	-21 60.7***	-	R^2= 0.254***	P< 0.000	48273.6	37031.6	1095191.0
	3rd order	20 524.0$	-396 12.4***	174 77.8***	-14 54.7***	R^2= 0.468***	P< 0.000	40917.5	28739.1	796532.6
2.	Linearized Compound	0***	1.46***	-	-	R^2= 0.092***	P< 0.000	63663.8	38097.3	113444.2
3.	Linearized Inverse	1618 1215***	-3.25 x10^10***	-	-	R^2= 0.173***	P< 0.000	50600.1	37250.7	785337.9
4.	Linearized Logarithmic	-12266 2120***	161 8537***	-	-	R^2= 0.173***	P< 0.000	50604.6	37254.2	785109.5
5.	Linearized Power	-	7 65.4***	-	-	R^2= 0.092***	P< 0.000	63662.5	38091.5	113538.1
6.	Linearized Exponential	0***	0.38***	-	-	R^2= 0.092***	P< 0.000	63663.8	38097.3	113444.2
7.	Linearized Growth	-75 6.8***	0.38***	-	-	R^2= 0.092***	P< 0.000	63663.8	38097.3	113444.2
8.	Linearized S-curve	774***	-1541 278***	-	-	R^2= 0.092***	P< 0.000	63661.2	38085.8	113632.2

9.	Exponential Smoothing	0.53	-	-	-	χ^2= 3.005	P< 0.000	35038.3	20558.8	42026.5
10.	ARIMA (0,1,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.008	P< 0.000 AIC= 2819	32528.2	20351.6	36872.9
Note:- Polynomial models upto 3rd order are significant.										
Notations:-										
*	Significant at 5% level of Significance									
**	Significant at 1% level of Significance									
***	Significant at 0.1% level of Significance									
$	Significant at 10% level of Significance									

From the Table 4.31, although many linearized models have significant R^2 values, the ARIMA(0,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2819), as indicated above, among various models fitted apart from lowest error measures like RMSE (32528.2), MAE (20351.64) and MAPE (36872.9). Thus, ARIMA model is chosen as best model for forecasting of soybean arrivals in Dongargaon market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of soybean in Dongargaon market were obtained as presented in the Table 4.32.

Table 4.32: Parameters of Fitted Model of Prices of Soybean in Dongargaon

S. N.	**Models**	**α**	**β_1**	**β_2**	**β_3**	**R^2 / Test-Statistics**	**P-value / AIC**	**RMSE**	**MAE**	**MAPE**
1.	Linearized Polynomial									
	1st order	-348 504.1***	174..2***	-	-	R^2= 0.238***	P< 0.000	900.9	569.1	48457.6
	2nd order	7659 25855$	-762 213.1$	18.9$	-	R^2= 0.256***	P< 0.000	894.0	575.3	45740.7
	3rd order	2065.3***	-96.1NS	48.1 NS	-2.1 NS	R^2= 0.528***	P< 0.000	897.0	580.9	45297.5
2.	Linearized Compound	1.20 x10-122$	1.15$	-	-	R^2= 0.024$	P= 0.084	1577.5	1525.2	21006.4
3.	Linearized Inverse	353 516.8***	-7069 85766***	-	-	R^2= 0.238***	P< 0.000	901.0	569.2	48471.0
4.	Linearized Logarithmic	-266 7964***	3351 010.5***	-	-	R^2= 0.238***	P< 0.000	901.0	569.2	48464.3
5.	Linearized Power	-	287.4$	-	-	R^2= 0.028$	P= 0.084	1577.8	1525.5	21014.7
6.	Linearized Exponential	1.20 x10-122$	0.14$	-	-	R^2= 0.024$	P= 0.084	1577.5	1525.2	21006.4
7.	Linearized Growth	-280.72$	0.14$	-	-	R^2= 0.024$	P= 0.084	1577.5	1525.2	21006.4

8.	Linearized S-curve	294.177$	-578 363.9$	-	-	R^2= 0.024$	P= 0.084	1578.0	1525.9	21022.9
9.	Exponential Smoothing	0.98	-	-	-	χ^2=35.4	P= 0.012	586.3	208.2	16404.3
10.	ARIMA (2,1,2) (1,0,1) [12]	-	-	-	-	χ^2=0.8	P< 0.000 AIC= 1852.7	548.0	261.2	15844.0

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.32, although many linearized models have significant R^2 values, the ARIMA(2,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1852.7), as indicated above, among various models fitted apart from Lowest error measures like RMSE (548.0), MAE (261.2) and MAPE (15844.0). Thus, ARIMA model is chosen as best model for forecasting of soybean prices in Dongargaon market.

4.8.1.4 Forecasting of Arrivals and Prices of Soybean in Dongargaon Market

After identification of the model, forecasting of arrivals and prices of soybean has been done. The best ARIMA model has been used to forecast the arrivals and prices of soybean in Dongargaon market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.33 and also depitcted in graph in Fig 4.22.

Table 4.33: Forecasted values of Arrivals and Prices of Soybean in Dongargaon Market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	29338.68	39963.70	3935.74	3928.96
February	40377.79	40419.94	3924.96	3924.12
March	40243.93	40414.41	3865.76	3919.00
April	40457.19	40423.22	3928.67	3926.52
May	40355.39	40419.02	3913.78	3923.44
June	39631.22	40389.09	3886.47	3921.17
July	39635.31	40389.26	3914.11	3925.12
August	39669.74	40390.68	3905.99	3923.23
September	39256.85	40373.61	3900.36	3922.26
October	42290.57	40499.00	3896.08	3924.32
November	42085.37	40490.52	3893.08	3923.20
December	39809.35	40396.45	3914.78	3922.81

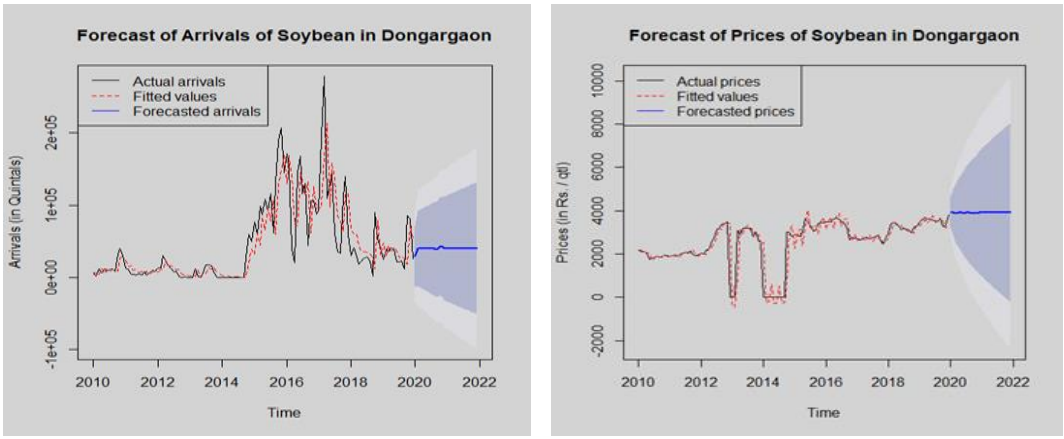


Fig. 4.22: Forecasts of Arrivals and Prices of Soybean in Dongargaon Market

From the Table 4.33, the highest forecasted arrivals of soybean for Dongargaon are expected to be 42290.57 quintals and 40499.00 quintals respectively in the month of October, 2020 and October, 2021 with respective forcasted prices to be Rs. 3896.08/quintal and Rs. 3924.32/quintal. However, the maximum prices were found to be Rs. 3935.74/quintal in the month of January, 2020 and Rs. 3928.96/quintal in the month of January, 2021.

4.9 Results for Arrivals and Prices of Oilseeds in Raipur Market

4.9.1 Mustard

4.9.1.1 Trend in Arrivals and Prices of Mustard in Raipur Market

Time series data for arrivals of mustard in Raipur has been presented in Fig. 4.23: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 1801 quintals in March 2014 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of mustard have also been plotted over the observed time series.

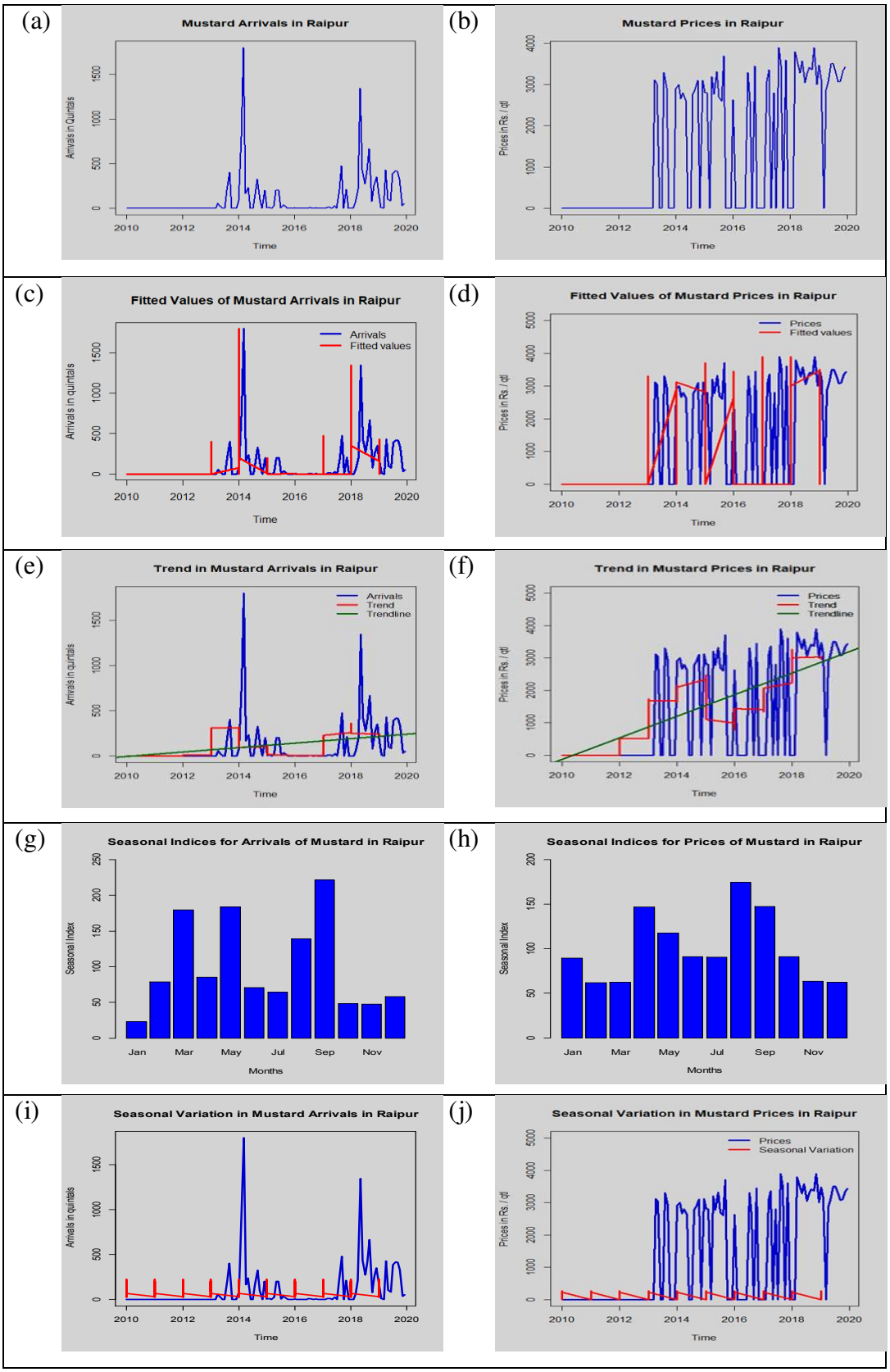
The linearized trend in the arrivals of mustard in Raipur has been indicated by dark-green line in the graph shown in Fig. 4.23: (e). It could be seen that the arrivals of mustard in Raipur had shown an increasing trend in arrivals over the years.

Similarly time series data for prices of mustard in Raipur has been presented in Fig. 4.23: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 3900 in August 2017 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the prices of mustard have also been plottted.

The linearized trend in the prices of mustard in Raipur has been indicated by dark-green line in the graph shown in Fig. 4.23: (f). It could be seen that the prices of mustard in Raipur had shown an increasing trend over the years.

4.9.1.2 Seasonality pattern in Arrivals and Prices of Mustard in Raipur Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.23: (g). The seasonal variation has been plotted in the graph of mustard arrivals in Raipur.



4.23 Trend and Seasonality pattern in Arrivals and Prices of Mustard in Raipur Market

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.23: (h). The seasonal variation has been plotted in the graph of mustard prices in Raipur.

4.9.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Mustard in Raipur Market

By fitting different linear and non-linear time series models, we got following results for arrivals of mustard in Raipur market were obtained as presented in the Table 4.34.

Table 4.34: Parameters of Fitted Model of Arrivals of Mustard in Raipur Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-50316.6**	25.02**	-	-	R^2= 0.085**	P= 0.001	236.6	124.9	8421.5
	2nd order	2781970NS	-2786.8 NS	0.6 NS	-	R^2= 0.086**	P= 0.005	237.6	123.3	8102.3
	3rd order	-29.8 NS	72.6 NS	-15.0 NS	1.1 NS	R^2= 0.093**	P= 0.009	237.7	127.7	9089.8
2.	Linearized Compound	0***	1.71***	-	-	R^2= 0.304***	P< 0.000	260.4	101.4	6838.0
3.	Linearized Inverse	50519.7**	-1015 62602**	-	-	R^2= 0.085**	P= 0.001	236.6	124.9	8427.1
4.	Linearized Logarithmic	-383484**	50418.1**	-	-	R^2= 0.085**	P= 0.001	236.6	124.9	8424.3
5.	Linearized Power	-	1086.4***	-	-	R^2= 0.304***	P< 0.000	260.4	101.4	6838.0
6.	Linearized Exponential	0***	0.53***	-	-	R^2= 0.304***	P< 0.000	260.4	101.4	6838.0
7.	Linearized Growth	-1084.9***	0.53***	-	-	R^2= 0.304***	P< 0.000	260.4	101.4	6838.0
8.	Linearized S-curve	1087.9***	-218 8518***	-	-	R^2= 0.304***	P< 0.000	260.5	101.4	6838.0
9.	Exponential Smoothing	0.18	-	-	-	χ^2= 6.31	P< 0.000	234.8	104.6	4270.5
10.	ARIMA (2,1,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.01	P< 0.000 AIC= 1641.3	223.2	102.2	3781.3

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.34, although many linearized models have significant R^2 values, the ARIMA(2,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1641.3), as indicated above, among various models fitted apart from lowest error measures like RMSE (223.2), MAE (102.2) and MAPE (3781.3). Thus, ARIMA model is chosen as best model for forecasting of mustard arrivals in Raipur market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of mustard in Raipur market were obtained as presented in the Table 4.35.

Table 4.35: Parameters of Fitted Model of Prices of Mustard in Raipur Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-669 280.6***	332.91***	-	-	R^2= 0.365***	P< 0.000	1269.9	1027.8	105383.3
	2nd order	-124 51747NS	120 30.5 NS	-2.9 NS	-	R^2= 0.365***	P< 0.000	1275.1	1033.6	106660.8
	3rd order	-307.94 NS	621.9 $	-79.9 NS	5.7 NS	R^2= 0.369***	P< 0.000	1276.6	1056.9	111702.9
2.	Linearized Compound	0***	2.4***	-	-	R^2= 0.340***	P< 0.000	1877.2	1262.4	71330.0
3.	Linearized Inverse	672 034.6***	-13510 53634***	-	-	R^2= 0.365***	P< 0.000	1269.9	1028.1	105456.3
4.	Linearized Logarithmic	-510 1078***	670 657.5***	-	-	R^2= 0.365***	P< 0.000	1269.9	1027.9	105419.8
5.	Linearized Power	-	1772.8***	-	-	R^2= 0.340***	P< 0.000	1877.5	1262.7	71304.0
6.	Linearized Exponential	0***	0.87***	-	-	R^2= 0.340***	P< 0.000	1877.2	1262.4	71330.0
7.	Linearized Growth	-1769.6***	0.87***	-	-	R^2= 0.340***	P< 0.000	1877.2	1262.4	71330.0
8.	Linearized S-curve	1775.9***	-357 1499***	-	-	R^2= 0.340***	P< 0.000	1877.8	1263.0	71279.0
9.	Exponential Smoothing	0.17		-	-	χ^2= 0.71	P< 0.000	1272.2	916.9	76333.8
10.	ARIMA (0,1,1) (1,0,1) [12]	-	-	-	-	χ^2= 0.45	P< 0.000 AIC= 1345.1	1264.9	899.6	70853.5

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.35, although many linearized models have significant R^2 values, the ARIMA(0,1,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1345.1), as indicated above, among various models fitted apart from lowest error measures like RMSE (1264.9), MAE (899.6) and MAPE (70853.5). Thus, ARIMA model is chosen as best model for forecasting of mustard prices in Raipur market.

4.9.1.4 Forecasting of Arrivals and Prices of Mustard in Raipur Market

After identification of the model, forecasting of arrivals and prices of mustard has been done. The best ARIMA model has been used to forecast the arrivals and prices of mustard in Raipur market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.36 and also depitcted in graph in Fig 4.24.

Table 4.36: Forecasted values of Arrivals and Prices of Mustard in Raipur Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	2021	2020	2021
January	174.63	217.45	3169.10	3164.03
February	213.54	217.46	3150.92	3161.94
March	217.86	217.47	2997.56	3144.38
April	217.71	217.46	3149.21	3161.75
May	217.45	217.46	3158.12	3162.77
June	217.43	217.46	3182.87	3165.60
July	217.50	217.46	3180.89	3165.38
August	217.51	217.46	3169.80	3164.11
September	217.50	217.46	3159.43	3162.92
October	217.49	217.46	3159.13	3162.88
November	217.42	217.46	3175.35	3164.74
December	217.42	217.46	3176.31	3164.85

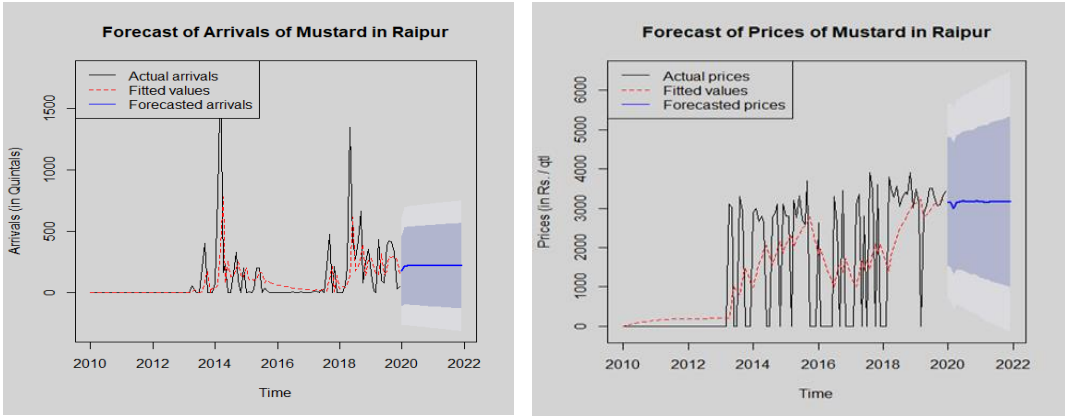


Fig. 4.24: Forecasts of Arrivals and Prices of Mustard in Raipur Market

From the Table 4.36, the highest forecasted arrivals of mustard for Raipur are expected to be 217.86 quintals and 217.47 quintals respectively in the month of March, 2020 and March, 2021 with respective forcasted prices to be Rs. 2997.56/quintal and Rs. 3144.38/quintal. However, the maximum prices were found to be Rs. 3182.87/quintal in the month of June, 2020 and Rs. 3165.60/quintal in the month of June, 2021.

4.10 Results for Arrivals and Prices of Oilseeds in Champa Market

4.10.1 Groundnut

4.10.1.1 Trend in Arrivals and Prices of Groundnut in Champa Market

Time series data for arrivals of groundnut in Champa has been presented in Fig. 4.25: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 56 quintals in March 2012 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut have also been plotted over the observed time series.

The linearized trend in the arrivals of groundnut in Champa has been indicated by dark-green line in the graph shown in Fig. 4.25: (e). It could be seen that the arrivals of groundnut in Champa had shown a decreasing trend over the years.

Similarly time series data for prices of groundnut in Champa has been presented in Fig. 4.25: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 5500 in December 2018 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Champa has been indicated by dark-green line in the graph shown in Fig. 4.25: (f). It could be seen that the prices of groundnut in Champa had shown a decreasing trend over the years.

4.10.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Champa Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices

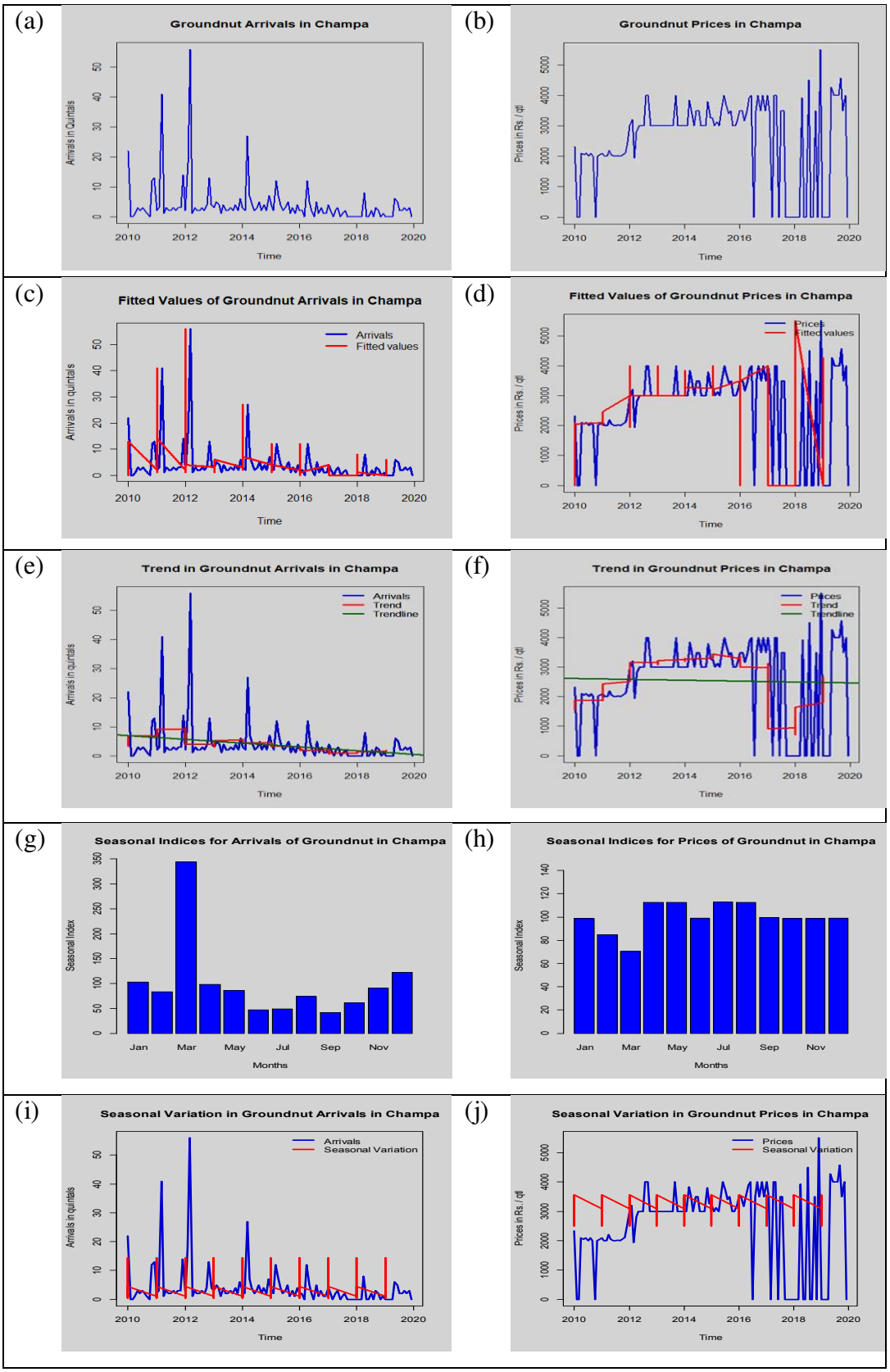


Fig. 4.25: Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Champa Market

has been shown in Fig. 4.25: (g). The seasonal variation is plotted in the graph of groundnut arrivals in Champa.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.25: (h). The seasonal variation has been plotted in the graph of groundnut prices in Champa.

4.10.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Champa Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Champa market were obtained as presented in the Table 4.37.

Table 4.37: Parameters of Fitted Model of Arrivals of Groundnut in Champa Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	1303.32**	-0.64**	-	-	R^2= 0.065**	P= 0.004	7.0	3.6	189.8
	2nd order	-154978.4NS	154.5 NS	-0.03 NS	-	R^2= 0.067**	P= 0.016	7.0	3.6	185.9
	3rd order	5.25**	2.01 NS	-0.71 NS	0.05 NS	R^2= 0.082**	P= 0.018	7.0	3.6	170.7
2.	Linearized Compound	$1.27x10^{113}$***	0.80***	-	-	R^2= 0.127***	P< 0.000	7.3	3.1	115.9
3.	Linearized Inverse	-1294.92**	2616829 **	-	-	R^2= 0.065**	P= 0.004	7.0	3.6	189.8
4.	Linearized Logarithmic	9887.98**	-1299.12**	-	-	R^2= 0.065**	P= 0.004	7.0	3.6	189.8
5.	Linearized Power	-	-259.54***	-	-	R^2= 0.127***	P< 0.000	7.0	3.6	115.9
6.	Linearized Exponential	$1.27x10^{113}$***	-0.12***	-	-	R^2= 0.127***	P< 0.000	7.0	3.6	115.9
7.	Linearized Growth	260.43***	- 0.12***	-	-	R^2= 0.127***	P< 0.000	7.0	3.6	115.9
8.	Linearized S-curve	-258.65***	522670.1***	-	-	R^2= 0.127***	P< 0.000	7.0	3.6	115.9
9.	Exponential Smoothing	0.21	-	-	-	χ^2= 0.72	P< 0.000	7.8	4.2	114.9
10.	ARIMA (0,1,1) (1,0,0) [12]	-	-	-	-	χ^2= 1.32	P< 0.000 AIC= 799.4	6.6	3.6	110.6

Note:- Polynomial models upto 3rd order are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.37, although many linearized models have significant R^2 values, the ARIMA(0,1,1)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=799.4), as indicated above, among various models fitted apart from lowest error measures like RMSE (6.6), MAE (3.6) and MAPE (110.6). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Champa market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Champa market were obtained as presented in the Table 4.38.

Table 4.38: Parameters of Fitted Model of Prices of Groundnut in Champa Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	323 34.9 ^{NS}	-14.7 ^{NS}	-	-	R^2= 0.000 ^{NS}	P= 0.742	1411.9	1411.9	96152.8
	2nd order	-3070 80543***	304888.2***	-75.6***	-	R^2= 0.155***	P< 0.000	1304.0	908.7	82272.3
	3rd order	1326.7***	1350.3***	-275.9**	14.8*	R^2= 0.189***	P< 0.000	1282.4	959.7	78284.0
2.	Linearized Compound	0***	0.65***	-	-	R^2= 0.122***	P< 0.000	2455.1	2064.5	24036.9
3.	Linearized Inverse	-267 65.8 ^{NS}	5904 1016 ^{NS}	-	-	R^2= 0.000	P= 0.746	1411.9	1153.2	96175.5
4.	Linearized Logarithmic	227 366 ^{NS}	-29550.4 ^{NS}	-	-	R^2= 0.000	P= 0.746	1411.9	1153.2	96164.1
5.	Linearized Power	-	-844.0***	-	-	R^2= 0.122***	P< 0.000	2455.1	2064.5	24043.5
6.	Linearized Exponential	0***	-0.14***	-	-	R^2= 0.122***	P< 0.000	2455.1	2064.5	24036.9
7.	Linearized Growth	850.9***	-0.14***	-	-	R^2= 0.122***	P< 0.000	2455.1	2064.5	24036.9
8.	Linearized S-curve	169 -837.1***	9324 ***	-	-	R^2= 0.122***	P< 0.000	2455.1	2064.5	24050.2
9.	Exponential Smoothing	0.20	-	-	-	χ^2= 0.032	P< 0.000	1285.0	836.8	23860.9
10.	ARIMA (1,0,1) (1,0,1) [12]	-	-	-	-	χ^2= 0.100	P< 0.000 AIC= 2061.8	1234.8	850.4	21702.5

Note:- Polynomial models upto 3rd order are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.38, although many linearized models have significant R^2 values, the ARIMA(1,0,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2061.8), as indicated above, among various models fitted apart from lowest error measures like RMSE (1234.8), MAE (850.4) and MAPE (21707.5). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Champa market.

4.10.1.4 Forecasting of Arrivals and Prices of Groundnut in Champa Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Champa market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.39 and also depitcted in graph in Fig 4.26.

Table 4.39: Forecasted values of Arrivals and Prices of Groundnut in Champa Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	1.43	1.94	3129.70	2807.55
February	1.43	1.94	3185.73	2834.83
March	1.43	1.94	3480.34	2976.13
April	1.43	1.94	2634.00	2571.98
May	3.56	2.69	2293.15	2409.44
June	3.20	2.57	2637.00	2574.20
July	2.14	2.19	2016.70	2278.02
August	2.14	2.19	2395.23	2459.31
September	2.49	2.32	2531.24	2524.64
October	2.14	2.19	2373.42	2449.49
November	2.49	2.32	2659.48	2586.51
December	1.43	1.94	2753.05	2631.50

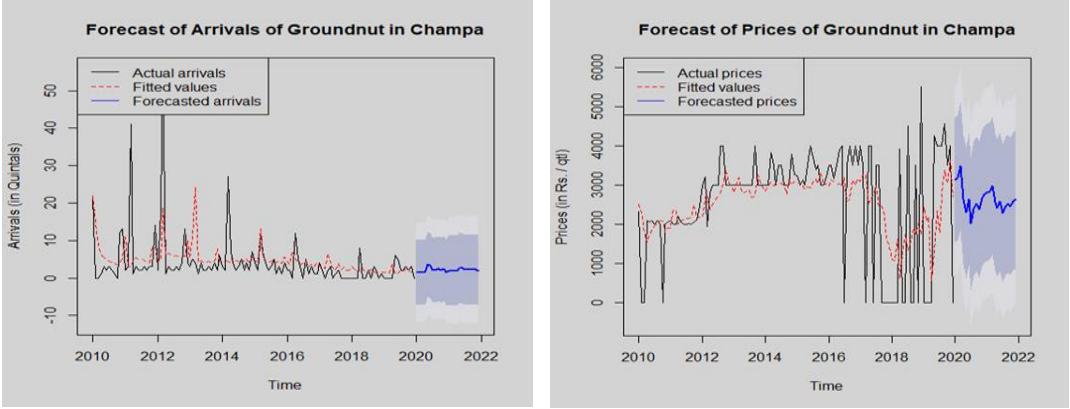


Fig. 4.26: Forecasts of Arrivals and Prices of Groundnut in Champa Market

From the Table 4.39, the highest forecasted arrivals of groundnut for Champa are expected to be 3.56 quintals and 2.69 quintals respectively in the month of May, 2020 and May, 2021 with respective forcasted prices to be Rs. 2293.15/quintal and Rs. 2409.44/quintal. However, the maximum prices were found to be Rs. 3185.87/quintal in the month of February, 2020 and Rs. 2976.13/quintal in the month of March, 2021.

4.10.2 Mustard

4.10.2.1 Trend in Arrivals and Prices of Mustard in Champa Market

Time series data for arrivals of mustard in Champa has been presented in Fig. 4.27: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 83 quintals in March 2012 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of mustard have also been plotted over the observed time series.

The linearized trend in the arrivals of mustard in Champa has been indicated by dark-green line in the graph shown in Fig. 4.27: (e). It could be seen that the arrivals of mustard in Champa had shown a decreasing trend over the years.

Similarly time series data for prices of mustard in Champa has been presented in Fig. 4.27: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 7000 in August 2015 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of mustard have also been plottted.

The linearized trend in the prices of mustard in Champa has been indicated by dark-green line in the graph shown in Fig. 4.27: (f). It could be seen that the prices of mustard in Champa had shown an increasing trend over the years.

4.10.2.2 Seasonality pattern in Arrivals and Prices of Mustard in Champa Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.27: (g). The seasonal variation has been plotted in the graph of mustard arrivals in Champa.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices

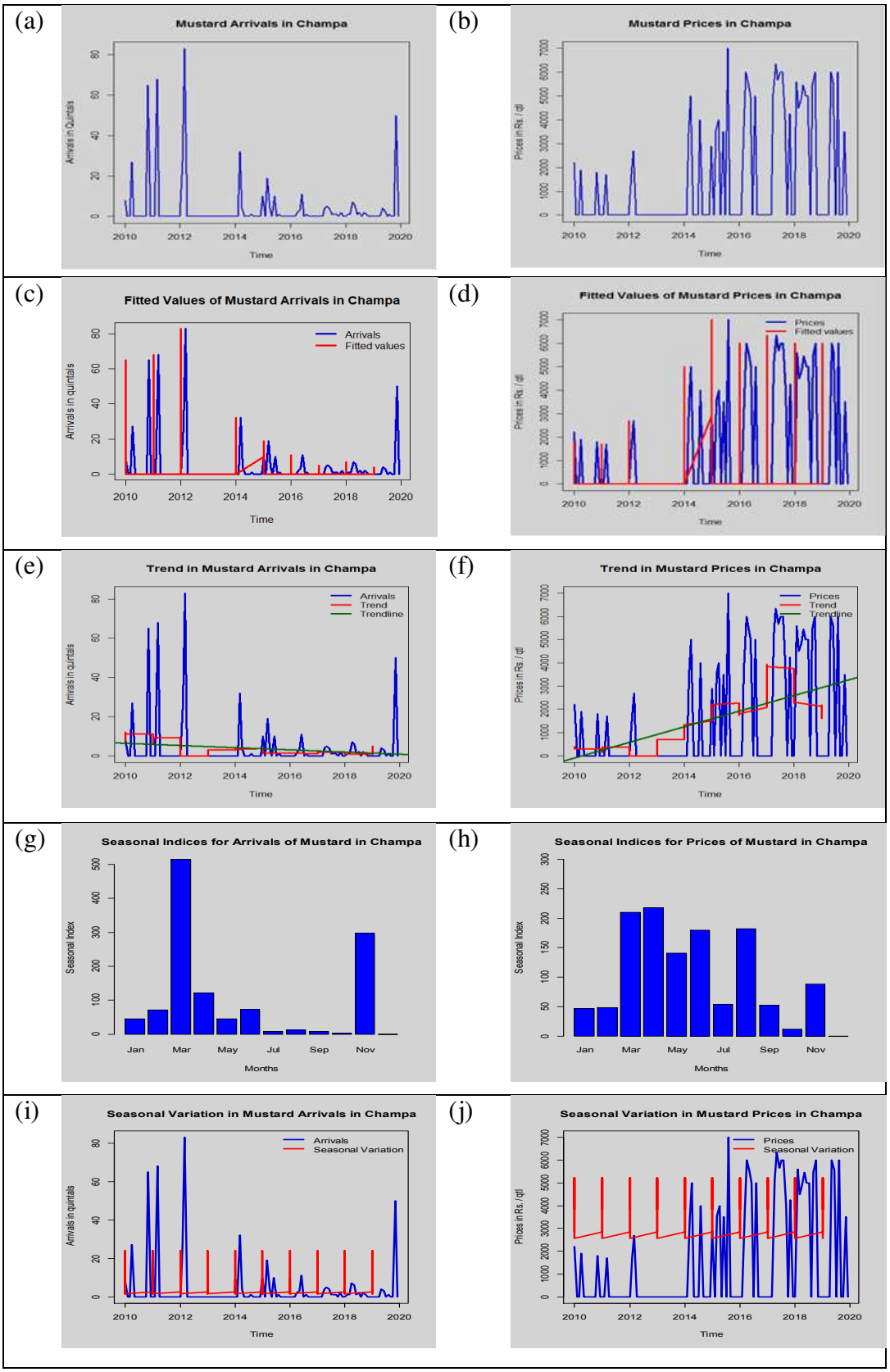


Fig. 4.27: Trend and Seasonality pattern in Arrivals and Prices of Mustard in Champa Market

has been shown in Fig. 4.27: (h). The seasonal variation has been plotted in the graph of mustard prices in Champa.

4.10.2.3 Identifying the Best Forecasting Model for Arrivals and Prices of Mustard in Champa Market

By fitting different linear and non-linear time series models, we got following results for arrivals of mustard in Champa market were obtained as presented in the Table 4.40.

Table 4.40: Parameters of Fitted Model of Arrivals of Mustard in Champa

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	1132.2^{NS}	-0.56^{NS}	-	-	R^2= 0.015^{NS}	P= 0.173	12.8	6.2	616.2
	2nd order	799194.1^{NS}	-792.8^{NS}	0.1^{NS}	-	R^2= 0.028^{NS}	P= 0.189	12.8	6.1	612.1
	3rd order	8.2*	-1.2^{NS}	-0.1^{NS}	0.02^{NS}	R^2= 0.029^{NS}	P= 0.328	12.8	6.2	620.3
2.	Linearized Compound	3.15 x10$^{-22\,NS}$	1.02^{NS}	-	-	R^2= 0.003^{NS}	P= 0.549	13.3	4.3	552.7
3.	Linearized Inverse	-1125.6^{NS}	22 75530^{NS}	-	-	R^2= 0.015^{NS}	P= 0.172	12.8	6.2	616.3
4.	Linearized Logarithmic	8593.14^{NS}	-1128.9^{NS}	-	-	R^2= 0.015^{NS}	P= 0.172	12.8	6.2	616.2
5.	Linearized Power	-	49.45^{NS}	-	-	R^2= 0.003^{NS}	P= 0.549	13.3	4.3	552.7
6.	Linearized Exponential	3.15 x10$^{-22\,NS}$	0.02^{NS}	-	-	R^2= 0.003^{NS}	P= 0.549	13.3	4.3	552.7
7.	Linearized Growth	-49.5^{NS}	0.02^{NS}	-	-	R^2= 0.003^{NS}	P= 0.549	13.3	4.3	552.7
8.	Linearized S-curve	49.4^{NS}	-99548.9^{NS}	-	-	R^2= 0.003^{NS}	P= 0.549	13.3	4.3	552.7
9.	Exponential Smoothing	0.03	-	-	-	χ^2= 0.027	P< 0.000	13.0	7.2	533.0
10.	ARIMA (0,0,0) (0,0,1) [12]	-	-	-	-	χ^2= 0.009	P< 0.000 AIC= 947.0	12.0	5.8	518.9

Note:-None of the Polynomial models are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.40, although many linearized models have significant R^2 values, the ARIMA(0,0,0)(0,0,1)[12] model has been found to be the best from

various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=947.0), as indicated above, among various models fitted apart from lowest error measures like RMSE (12.0), MAE (5.8) and MAPE (518.9). Thus, ARIMA model is chosen as best model for forecasting of mustard arrivals in Champa market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of mustard in Champa market were obtained as presented in the Table 4.41.

Table 4.41: Parameters of Fitted Model of Prices of Mustard in Champa Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-676 669.1***	336.6***	-	-	R^2= 0.186***	P< 0.000	2038.8	1679.1	169293.9
	2nd order	-332 2097NS	2962.9 NS	-0.6 NS	-	R^2= 0.186***	P< 0.000	2047.4	1680.3	169537.3
	3rd order	701.8 NS	-1121.9*	428.1**	-31.7**	R^2= 0.248***	P< 0.000	1976.3	1553.5	157199.6
2.	Linearized Compound	0***	1.62***	-	-	R^2= 0.110***	P< 0.000	2659.9	1450.2	226761.0
3.	Linearized Inverse	679 518.4***	-13660 18582***	-	-	R^2= 0.186***	P< 0.000	2038.7	1679.4	169356.4
4.	Linearized Logarithmic	-515 7599***	678 093.9***	-	-	R^2= 0.186***	P< 0.000	2038.8	1679.2	169325.2
5.	Linearized Power	-	983.7***	-	-	R^2= 0.110***	P< 0.000	2659.9	1450.2	226632.8
6.	Linearized Exponential	0***	0.48***	-	-	R^2= 0.110***	P< 0.000	2659.9	1450.2	226763.0
7.	Linearized Growth	-98 1.6***	0.48***	-	-	R^2= 0.110***	P< 0.000	2659.9	1450.2	226763.0
8.	Linearized S-curve	98 5.8***	198 1709***	-	-	R^2= 0.110***	P< 0.000	2659.9	1450.1	226576.0
9.	Exponential Smoothing	0.14	-	-	-	χ^2= 4.2	P< 0.000	2105.1	1652.8	166689.2
10.	ARIMA (3,1,2) (2,0,0) [12]	-	-	-	-	χ^2= 0.0004	P< 0.000 AIC= 2150.4	1864.5	1370	128739.9

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.41, although many linearized models have significant R^2 values, the ARIMA(3,1,2)(2,0,0)[12] model has been found to be the best from

various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2150.4), as indicated above, among various models fitted apart from lowest error measures like RMSE (1864.51), MAE (1370) and MAPE (128739.9). Thus, ARIMA model is chosen as best model for forecasting of mustard prices in Champa market.

4.10.2.4 Forecasting of Arrivals and Prices of Mustard in Champa Market

After identification of the model, forecasting of arrivals and prices of mustard has been done. The best ARIMA model has been used to forecast the arrivals and prices of mustard in Champa market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.42 and also depitcted in graph in Fig 4.10.2.2.

Table 4.42: Forecasted values of Arrivals and Prices of Mustard in Champa Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	3.08	4.19	1045.87	1458.87
February	2.73	4.19	1730.82	1854.39
March	2.78	4.19	1722.25	1842.41
April	1.95	4.18	2002.95	2024.43
May	3.84	4.19	3645.53	3094.21
June	4.12	4.19	3472.47	2981.48
July	2.66	4.19	1925.95	1974.16
August	3.42	4.19	3119.57	2751.62
September	2.66	4.19	1892.52	1952.38
October	2.76	4.19	1789.92	1885.55
November	24.35	4.20	2265.28	2195.18
December	2.94	4.19	1177.42	1486.60

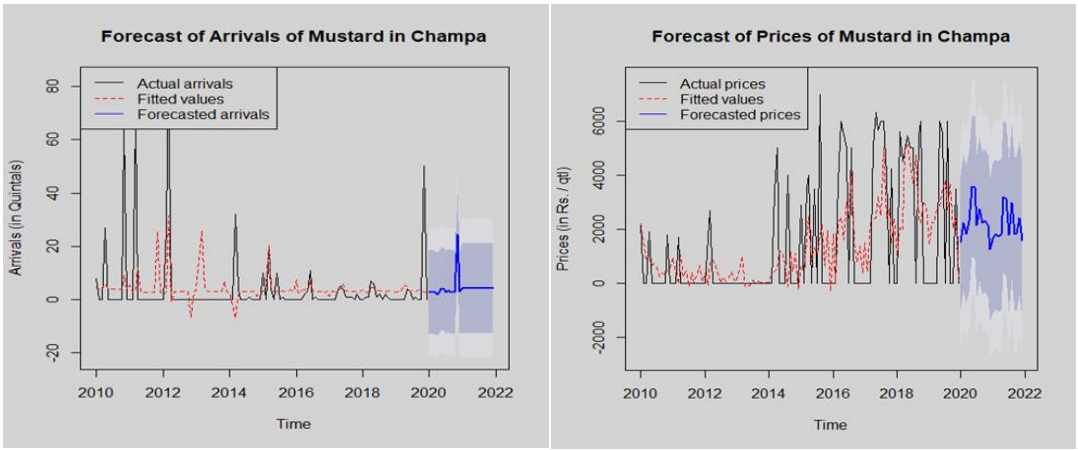


Fig. 4.28: Forecasts of arrivals and prices of Mustard in Champa Market

From the Table 4.42, the highest forecasted arrivals of mustard for Champa are expected to be 24.35 quintals and 4.20 quintals respectively in the month of November, 2020 and November, 2021 with respective forcasted prices to be Rs. 2265.28/quintal and Rs. 2195.18/quintal. However, the maximum prices were found to be Rs. 3645.53/quintal in the month of May, 2020 and Rs. 3094.21/quintal in the month of May, 2021.

4.11 Results for Arrivals and Prices of Oilseeds in Pendra Road Market

4.11.1 Linseed

4.11.1.1 Trend in Arrivals and Prices of Linseed in Pendra Road Market

Time series data for arrivals of linseed in Pendra Road has been presented in Fig. 4.29: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 590 quintals in November 2010 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of linseed has been plotted there.

The linearized trend in the arrivals of linseed in Pendra Road has been indicated by dark-green line in the graph shown in Fig. 4.29: (e). It could be seen that the arrivals of linseed in Pendra Road had shown an decreasing trend over the years.

Similarly time series data for prices of linseed in Pendra Road has been presented in Fig. 4.29: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4000 in June 2016 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of linseed have also been plottted.

The linearized trend in the prices of linseed in Pendra Road has been indicated by dark-green line in the graph as shown in the Fig. 4.29: (f). It could be seen that the prices of linseed in Pendra Road had shown an decreasing trend over the years.

4.11.1.2 Seasonality pattern in Arrivals and Prices of Linseed in Pendra Road Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices

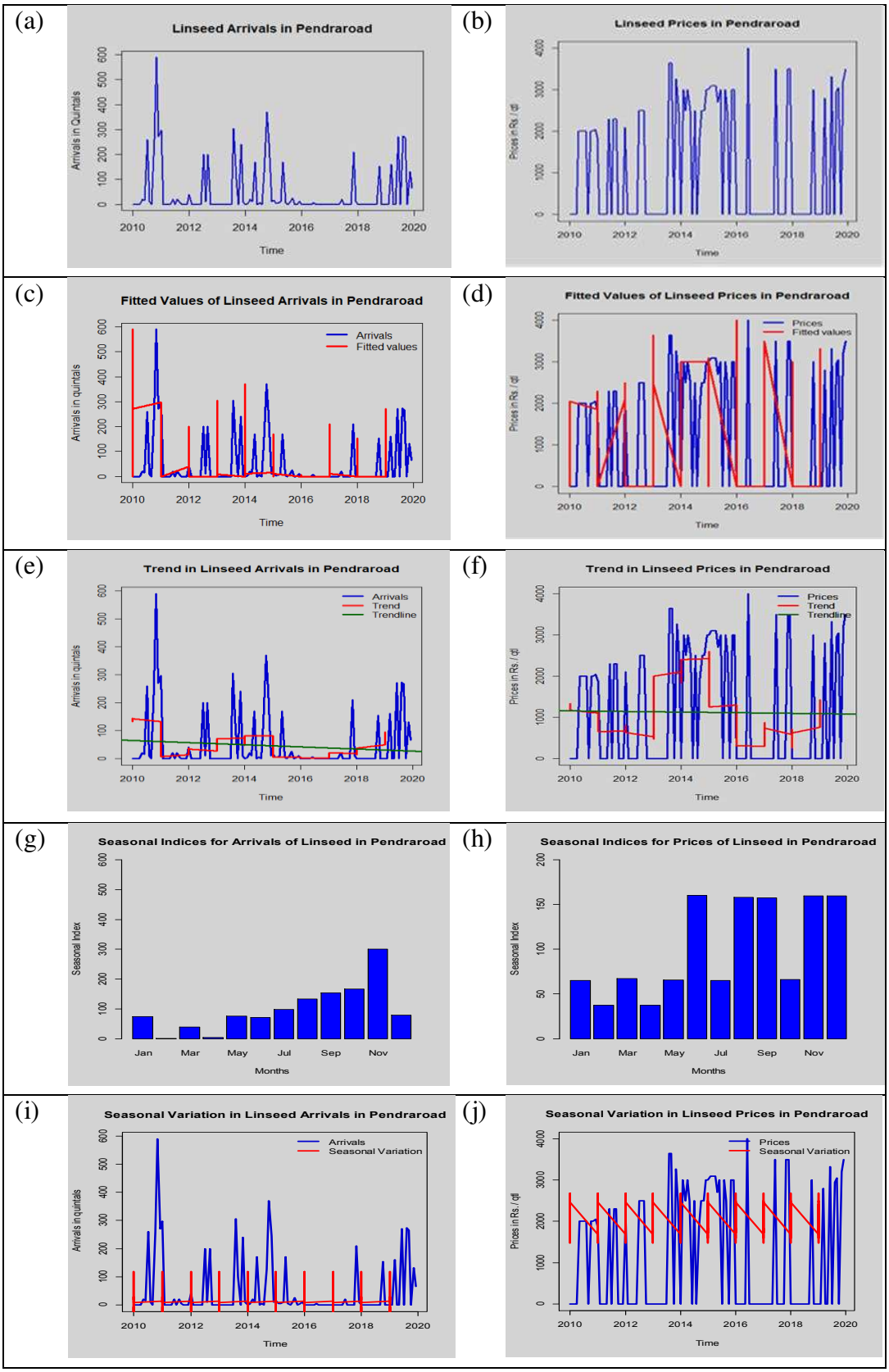


Fig. 4.29: Trend and Seasonality pattern in Arrivals and Prices of Linseed in Pendra Road Market

has been shown in Fig. 4.29: (g). The seasonal variation is plotted in the graph of linseed arrivals in Pendra Road.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.29: (h). The seasonal variation has been plotted in the graph of linseed prices in Pendra Road.

4.11.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Linseed in Pendra Road Market

By fitting different linear and non-linear time series models, we got following results for arrivals of linseed in Pendra Road market were obtained as presented in the Table 4.43.

Table 4.43: Parameters of Fitted Model of Arrivals of Linseed in Pendra Road Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	7522.1^{NS}	-3.71^{NS}	-	-	R^2= 0.011^{NS}	P= 0.252	101.4	70.8	5572.0
	2nd order	1155 0596*	-11463.7*	2.8*	-	R^2= 0.052*	P= 0.041	99.7	67.8	5625.1
	3rd order	86.6**	-8.6^{NS}	-3.1^{NS}	0.4^{NS}	R^2= 0.058*	P= 0.034	99.8	66.9	5569.3
2.	Linearized Compound	3.29 x10$^{78\ NS}$	0.91^{NS}	-	-	R^2= 0.011^{NS}	P= 0.247	111.1	48.3	3930.0
3.	Linearized Inverse	-7446.9^{NS}	15094997^{NS}	-	-	R^2= 0.011^{NS}	P= 0.251	101.4	70.8	5571.8
4.	Linearized Logarithmic	5698.0^{NS}	-7484.10^{NS}	-	-	R^2= 0.011^{NS}	P= 0.251	101.4	70.8	5571.9
5.	Linearized Power	-	-197.78^{NS}	-	-	R^2= 0.011^{NS}	P= 0.247	111.1	48.3	3930.0
6.	Linearized Exponential	3.29 x10$^{78\ NS}$	-0.08^{NS}	-	-	R^2= 0.011^{NS}	P= 0.247	111.1	48.3	3930.0
7.	Linearized Growth	180.7^{NS}	-0.08^{NS}	-	-	R^2= 0.011^{NS}	P= 0.247	111.1	48.3	3930.0
8.	Linearized S-curve	178.79^{NS}	362366.2^{NS}	-	-	R^2= 0.011^{NS}	P= 0.247	111.1	48.3	3930.0
9.	Exponential Smoothing	0.25	-	-	-	χ^2= 2.32	P< 0.000	101.5	62.1	3920.0
10.	ARIMA (1,0,0) (1,0,1) [12]	-	-	-	-	χ^2= 0.05	P< 0.000 AIC= 1441.3	95.3	64.3	3872.2

Note:- Polynomial models upto 3rd order are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.43, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1441.3), as indicated above, among various models fitted apart from lowest error measures like RMSE (95.33), MAE (64.34) and MAPE (3872.2). Thus, ARIMA model is chosen as best model for forecasting of linseed arrivals in Pendra Road market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of linseed in Pendra Road market were obtained as presented in the Table 4.44.

Table 4.44: Parameters of Fitted Model of Prices of Linseed in Pendra Road Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	15184.8^{NS}	-6.9^{NS}	-	-	R^2= 0.000^{NS}	P= 0.876	1405.9	1325.2	132549.0
	2nd order	-7934 1021^{NS}	78 778.1^{NS}	-1 9.5^{NS}	-	R^2= 0.010^{NS}	P= 0.536	1404.6	1318.7	131897.2
	3rd order	732.6*	509.6^{NS}	-11 9.2^{NS}	7.3^{NS}	R^2= 0.019^{NS}	P= 0.519	1404.4	1310.1	131040.1
2.	Linearized Compound	6.66 x10$^{146\,NS}$	0.84^{NS}	-	-	R^2= 0.012^{NS}	P= 0.218	1793.1	1143.5	2152.0
3.	Linearized Inverse	128 15.4^{NS}	2807 7032^{NS}	-	-	R^2= 0.000^{NS}	P= 0.877	1405.9	1325.2	132551.3
4.	Linearized Logarithmic	10 7637^{NS}	14 000.1^{NS}	-	-	R^2= 0.000^{NS}	P= 0.876	1405.9	1325.2	132550.1
5.	Linearized Power	-	-335.1^{NS}	-	-	R^2= 0.012^{NS}	P= 0.218	1793.1	1143.5	2151.9
6.	Linearized Exponential	6.66 x10$^{146\,NS}$	-0.16^{NS}	-	-	R^2= 0.012^{NS}	P= 0.218	1793.1	1143.5	2152.0
7.	Linearized Growth	338.0^{NS}	-0.16^{NS}	-	-	R^2= 0.012^{NS}	P= 0.218	1793.1	1143.5	2152.0
8.	Linearized S-curve	-332.2^{NS}	674 968.6^{NS}	-	-	R^2= 0.012^{NS}	P= 0.218	1793.1	1143.5	2151.9
9.	Exponential Smoothing	0.20	-	-	-	χ^2= 0.213	P< 0.000	1362.3	1108.2	102348.2
10.	ARIMA (1,0,1) (1,0,1) [12]	-	-	-	-	χ^2= 0.102	P< 0.000 AIC= 2077.2	1315.7	1176.4	1315.7

Note:- None of the Polynmial model is significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.44, although many linearized models have significant R^2 values, the ARIMA(1,0,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2077.2), as indicated above, among various models fitted apart from lowest error measures like RMSE (1315.7), MAE (1176.4) and MAPE (1315.7). Thus, ARIMA model is chosen as best model for forecasting of linseed prices in Pendra Road market.

4.11.1.4 Forecasting of Arrivals and Prices of Linseed in Pendra Road Market

After identification of the model, forecasting of arrivals and prices of linseed has been done. The best ARIMA model has been used to forecast the arrivals and prices of linseed in Pendra Road market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.45 and also depitcted in graph in Fig 4.30.

Table 4.45: Forecasted values of Arrivals and Prices of linseed in Pendra Road Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	55.40	44.99	1692.54	1123.47
February	52.21	45.32	1585.01	1099.27
March	34.90	47.00	1596.67	1176.21
April	50.79	45.46	1420.35	1066.69
May	50.68	45.47	1369.35	1067.04
June	23.12	48.15	1678.95	1399.91
July	50.62	45.48	1244.66	1026.49
August	22.90	48.17	1476.28	1274.90
September	23.61	48.10	1440.76	1267.44
October	50.55	45.48	1192.66	1056.12
November	37.32	46.77	1464.49	1331.08
December	44.02	46.12	1448.70	1332.52

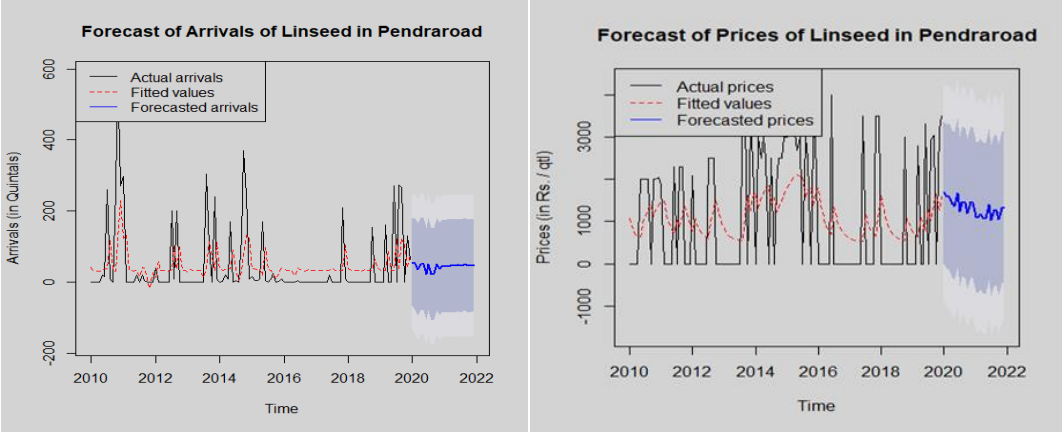


Fig. 4.30: Forecasts of Arrivals and Prices of Linseed in Pendra Road Market

From the Table 4.45, the highest forecasted arrivals of linseed for Pendra Road are expected to be 55.40 quintals and 44.99 quintals respectively in the month of January, 2020 and January, 2021 with respective forcasted prices to be Rs. 1692.54/quintal and Rs. 1123.47/quintal. However, the maximum prices were found to be Rs. 1692.54/quintal in the month of January, 2020 and Rs. 1399.91/quintal in the month of June, 2021.

4.12 Results for Arrivals and Prices of Oilseeds in Mungeli Market

4.12.1 Soybean

4.12.1.1 Trend in Arrivals and Prices of Soybean in Mungeli Market

Time series data for arrivals of soybean in Mungeli has been presented in Fig. 4.31: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 52830 quintals in November 2013 and minimum 47 quintal in September 2013. In this case, multiplicative model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of soybean have also been plotted over the observed time series.

The linearized trend in the arrivals of soybean in Mungeli has been indicated by dark-green line in the graph shown in Fig. 4.31: (e). It could be seen that the arrivals of soybean in Mungeli had shown an decreasing trend over the years.

Similarly time series data for prices of soybean in Mungeli has been presented in Fig. 4.31: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4458.44 in August 2012 and minimum is Rs. 1827.17 in June 2010. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of soybean have also been plottted.

The linearized trend in the prices of soybean in Mungeli has been indicated by dark-green line in the graph shown in Fig. 4.31: (f). It could be seen that the prices of soybean in Mungeli had shown an increasing trend over the years.

4.12.1.2 Seasonality pattern in Arrivals and Prices of Soybean in Mungeli Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.31: (g). The seasonal variation has been plotted in the graph of soybean arrivals in Mungeli.

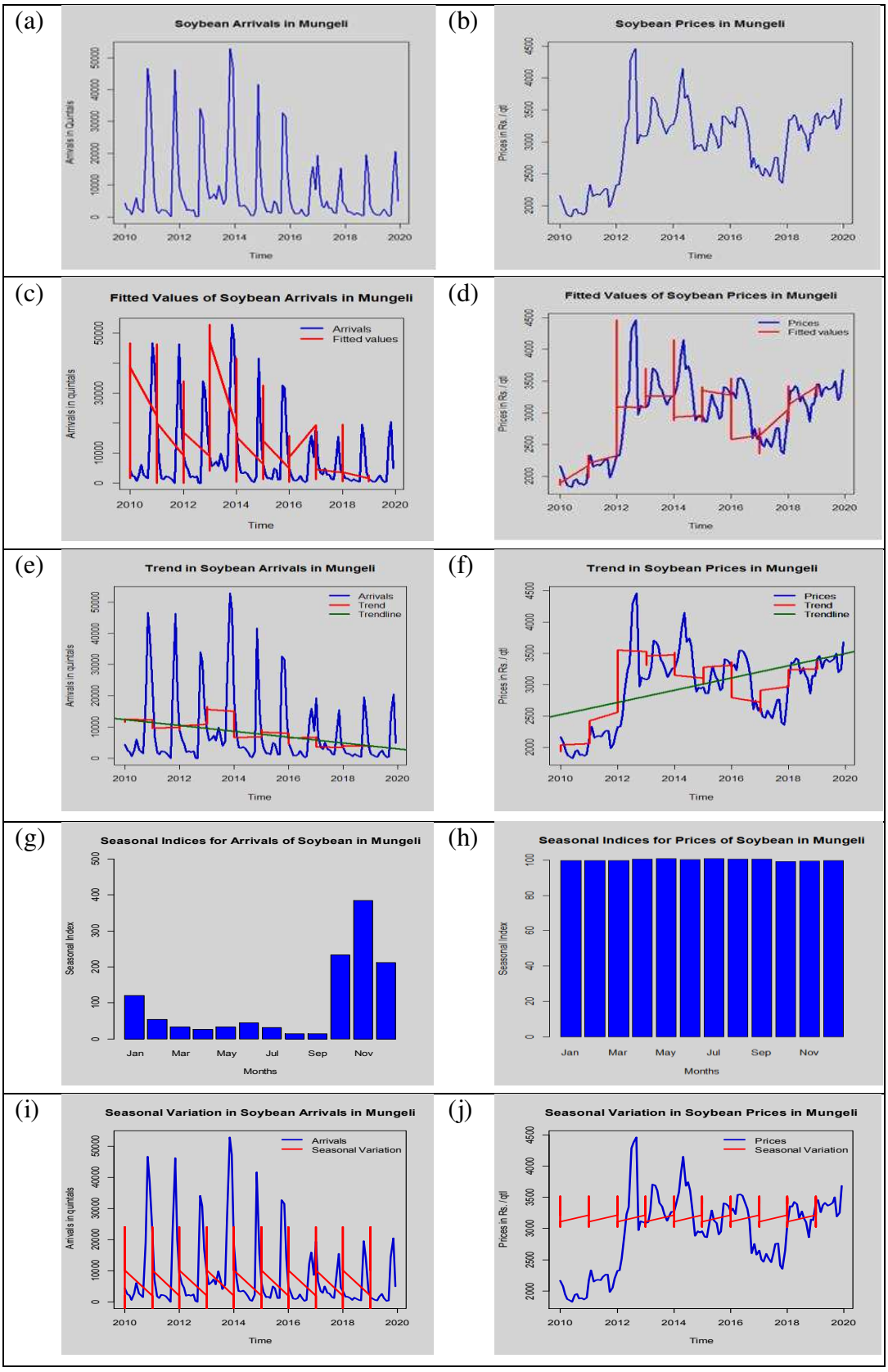


Fig. 4.31: Trend and Seasonality pattern in Arrivals and Prices of Soybean in Mungeli Market

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.31: (h). The seasonal variation is plotted in the graph of soybean prices in Mungeli.

4.12.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Soybean in Mungeli Market

By fitting different linear and non-linear time series models, we got following results for arrivals of soybean in Mungeli market were obtained as presented in the Table 4.46.

Table 4.46: Parameters of Fitted Model of Arrivals of Soybean in Mungeli Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	1904881**	-941.51**	-	-	R^2= 0.055**	P= 0.009	11238.8	7983.9	683.3
	2nd order	-3776 61263^{NS}	375 893.4^{NS}	-93.5^{NS}	-	R^2= 0.059**	P= 0.028	11265.7	7977.1	672.6
	3rd order	9990.9***	2331.7^{NS}	-805.5^{NS}	52.7^{NS}	R^2= 0.065**	P= 0.047	11274.8	7981.0	700.2
2.	Linearized Compound	2.90 x10^{90*}	0.90*	-	-	R^2= 0.041*	P= 0.024	12283.9	6791.4	286.2
3.	Linearized Inverse	-188 7864**	3819** 624431	-	-	R^2= 0.055**	P= 0.009	11239.0	7984.0	683.4
4.	Linearized Logarithmic	1443 6045**	-189 6372**	-	-	R^2= 0.055**	P= 0.009	11239.0	7984.0	683.4
5.	Linearized Power	-	-200.06*	-	-	R^2= 0.041*	P= 0.024	12283.9	6791.4	286.2
6.	Linearized Exponential	2.90 x10^{90*}	-0.09*	-	-	R^2= 0.041*	P= 0.024	12283.9	6791.4	286.2
7.	Linearized Growth	208.29*	-0.09*	-	-	R^2= 0.041*	P= 0.024	12283.9	6791.4	286.2
8.	Linearized S-curve	-191.82*	402 846.9*	-	-	R^2= 0.041*	P= 0.024	12283.9	6791.4	286.2
9.	Exponential Smoothing	0.99	-	-	-	χ^2= 1.09	P< 0.000	10309.6	5884.7	108.0
10.	ARIMA (1,0,0) (0,1,1) [12]	-	-	-	-	χ^2= 0.31	P< 0.000 AIC= 2209.9	5999.3	3196.3	75.1

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.46, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(0,1,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2209.9), as indicated above, among various models fitted apart from lowest error measures like RMSE (5999.3), MAE (3196.3) and MAPE (75.1). Thus, ARIMA model is chosen as best model for forecasting of soybean arrivals in Mungeli market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of soybean in Mungeli market were obtained as presented in the Table 4.47.

Table 4.47: Parameters of Fitted Model of Prices of Soybean in Mungeli Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Sttistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-193476.7***	97.51***	-	-	R^2= 0.22***	P< 0.000	530.7	416.4	14.9
	2nd order	-13708 8492***	136007.5***	-33.73***	-	R^2= 0.38***	P< 0.000	471.6	358.8	12.3
	3rd order	1723.94***	1116.01***	-243.08***	15.50***	R^2= 0.59***	P< 0.000	384.0	292.7	10.3
2.	Linearized Compound	1.87 x10^{-31}***	1.03***	-	-	R^2= 0.27***	P< 0.000	542.1	428.8	14.6
3.	Linearized Inverse	199609***	-3961 51897***	-	-	R^2= 0.22***	P< 0.000	530.6	416.3	14.9
4.	Linearized Logarithmic	-149 2364***	196542.8***	-	-	R^2= 0.22***	P< 0.000	530.6	416.3	14.9
5.	Linearized Power	-	78.76***	-	-	R^2= 0.27***	P< 0.000	542.1	428.8	14.6
6.	Linearized Exponential	1.87 x10^{-31}***	0.03***	-	-	R^2= 0.27***	P< 0.000	542.1	428.8	14.6
7.	Linearized Growth	-70.75***	0.03***	-	-	R^2= 0.27***	P< 0.000	542.1	428.8	14.6
8.	Linearized S-curve	86.77***	-158 757.1***	-	-	R^2= 0.27***	P< 0.000	542.1	428.8	14.6
9.	Exponential Smoothing	0.99	-	-	-	χ^2= 0.86	P< 0.000	240.4	149.6	4.9
10.	ARIMA (0,1,0) (2,0,0) [12]	-	-	-	-	χ^2= 0.81	P< 0.000 AIC= 1640	229.8	139.9	4.6

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.47, although many linearized models have significant R^2 values, the ARIMA(0,1,0)(2,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1640), as indicated above, among various models fitted apart from lowest error measures like RMSE (229.8), MAE (139.9) and MAPE (4.6). Thus, ARIMA model is chosen as best model for forecasting of soybean prices in Mungeli market.

4.12.1.4 Forecasting of Arrivals and Prices of Soybean in Mungeli Market

After identification of the model, forecasting of arrivals and prices of soybean has been done. The best ARIMA model has been used to forecast the arrivals and prices of soybean in Mungeli market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.48 and also depitcted in graph in Fig 4.32.

Table 4.48: Forecasted values of Arrivals and Prices of Soybean in Mungeli Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	4485.72	5936.97	3798.41	3922.39
February	1913.82	2587.49	3861.00	3940.03
March	1261.64	1574.36	3829.68	3898.10
April	1258.47	1403.64	3861.06	3923.69
May	1974.99	2042.37	3860.30	3930.99
June	2664.29	2695.58	3812.70	3915.52
July	1784.55	1799.07	3833.62	3921.18
August	729.84	736.59	3817.34	3925.10
September	767.32	770.45	3819.37	3941.61
October	15911.22	15912.67	3728.10	3870.80
November	21332.96	21333.64	3790.62	3890.87
December	8050.34	8050.65	3852.22	3980.34

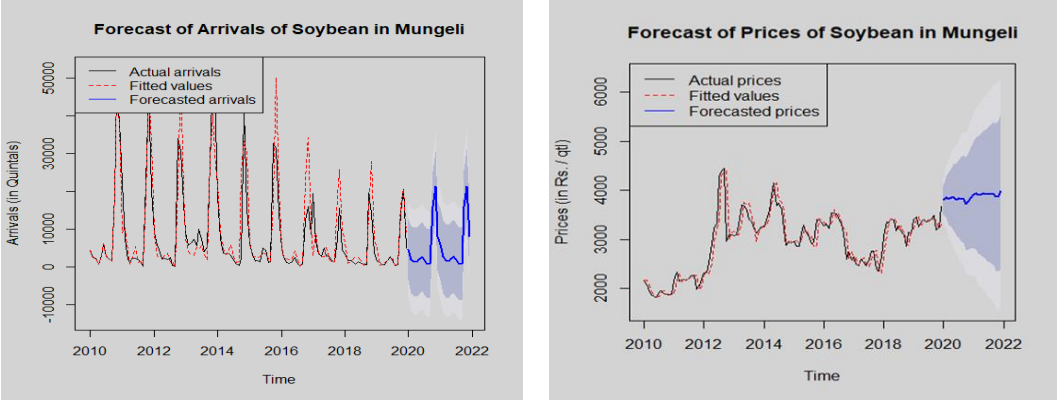


Fig. 4.32: Forecasts of Arrivals and Prices of Soybean in Mungeli Market

From the Table 4.48, the highest forecasted arrivals of Soybean for Mungeli are expected to be 21332.96 quintals and 23133.64 quintals respectively in the month of November, 2020 and November, 2021 with respective forcasted prices to be Rs. 3790.62/quintal and Rs. 3890.87/quintal. However, the maximum prices were found to be Rs. 3861.06/quintal in the month of April, 2020 and Rs. 3941.61/quintal in the month of September, 2021.

4.13 Results for Arrivals and Prices of Oilseeds in Ghadghoda Market

4.13. Groundnut

4.13.1.1 Trend in Arrivals and Prices of Groundnut in Ghadghoda Market

Time series data for arrivals of groundnut in Ghadghoda has been presented in Fig. 4.33: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 932 quintals in June 2016 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut have also been plotted over the observed time series.

The linearized trend in the arrivals of groundnut in Ghadghoda has been indicated by dark-green line in the graph shown in Fig. 4.33: (e). It could be seen that the arrivals of groundnut in Ghadghoda had shown a decreasing trend over the years.

Similarly time series data for prices of groundnut in Ghadghoda has been presented in Fig. 4.33: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4250 in November 2018 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Ghadghoda has been indicated by dark-green line in the graph shown in Fig. 4.33: (f). It could be seen that the prices of groundnut in Ghadghoda had shown an increasing trend over the years.

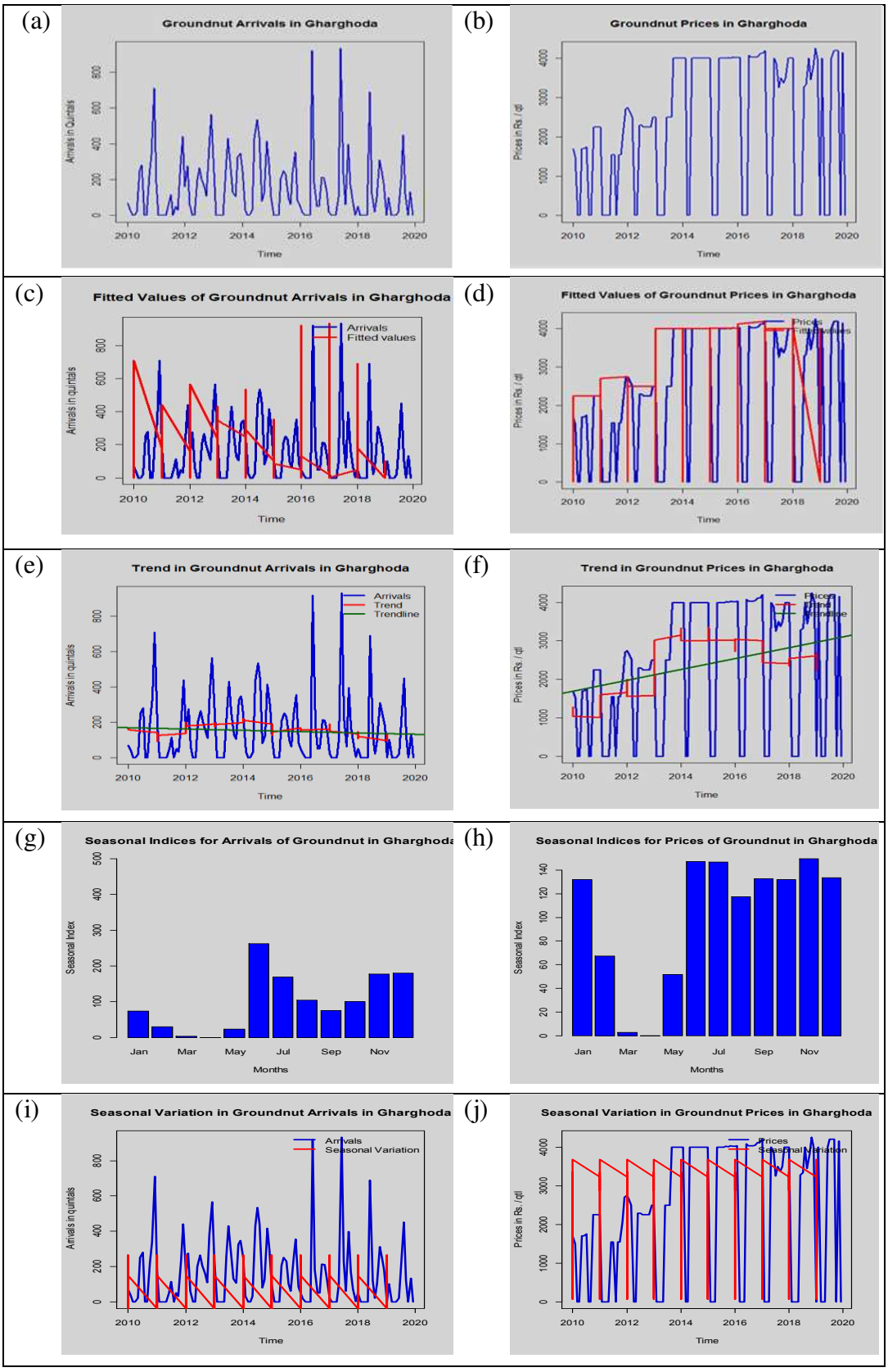


Fig. 4.33: Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Gharghoda Market

4.13.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Ghadghoda Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.33: (g). The seasonal variation has been plotted in the graph of groundnut arrivals in Ghadghoda.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.33: (h). The seasonal variation is plotted in the graph of groundnut prices in Ghadghoda.

4.13.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Ghadghoda Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Ghadghoda market were obtained as presented in the Table 4.49.

Table 4.49: Parameters of Fitted Model of Arrivals of Groundnut in Ghadghoda

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	7852.7^{NS}	-3.8^{NS}	-	-	R^2= 0.003^{NS}	P= 0.523	188.1	140.6	9257.0
	2nd order	-12496610^{NS}	12410.6^{NS}	-3.0^{NS}	-	R^2= 0.017^{NS}	P= 0.349	187.5	138.7	8930.8
	3rd order	137.7**	14.5^{NS}	-0.3^{NS}	-0.2^{NS}	R^2= 0.018^{NS}	P= 0.544	188.3	139.0	8917.3
2.	Linearized Compound	6.49 x10^{63} ^{NS}	0.93^{NS}	-	-	R^2= 0.005^{NS}	P= 0.416	227.0	144.8	1645.5
3.	Linearized Inverse	-7528.2^{NS}	1547 2607^{NS}	-	-	R^2= 0.003^{NS}	P= 0.524	188.1	140.6	9257.3
4.	Linearized Logarithmic	58662.7^{NS}	-7690.5^{NS}	-	-	R^2= 0.003^{NS}	P= 0.524	188.1	140.6	9257.2
5.	Linearized Power	-	-143.4^{NS}	-	-	R^2= 0.005^{NS}	P= 0.417	227.0	144.8	1645.4
6.	Linearized Exponential	6.49 x10^{63} ^{NS}	-0.07^{NS}	-	-	R^2= 0.005^{NS}	P= 0.416	227.0	144.8	1645.5
7.	Linearized Growth	146.9^{NS}	-0.07^{NS}	-	-	R^2= 0.005^{NS}	P= 0.416	227.0	144.8	1645.5
8.	Linearized S-curve	-139.9^{NS}	288 588.8^{NS}	-	-	R^2= 0.005^{NS}	P= 0.418	227.0	144.8	1645.4
9.	Exponential Smoothing	0.03	-	-	-	χ^2= 8.48	P <0.000	191.8	142.5	8339.5

10.	ARIMA (0,0,0) (1,1,0) [12]	-	-	-	-	χ^2= 1.76	P <0.000 AIC= 1541.9	147.9	90.6	1536.1

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.49, although many linearized models have significant R^2 values, the ARIMA(0,0,0)(1,1,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1541.9), as indicated above, among various models fitted apart from lowest error measures like RMSE (147.9), MAE (90.6) and MAPE (1536.1). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Ghadghoda market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Ghadghoda market were obtained as presented in the Table 4.50.

Table 4.50: Parameters of Fitted Model of Prices of Groundnut in Ghadghoda

S. N.	**Models**	**α**	**β_1**	**β_2**	**β_3**	**R^2 / Test-Statistics**	**P-value / AIC**	**RMSE**	**MAE**	**MAPE**
1.	Linearized Polynomial 1st order	-284 032.4**	142.1**	-	-	R^2= 0.057**	P= 0.008	1666.4	1435.5	141388.4
	2nd order	-28679 7667***	284 594.1***	-70.6***	-	R^2= 0.148***	P< 0.000	1590.8	1340.9	133857.1
	3rd order	1025.4*	441.2NS	27.8NS	-7.2NS	R^2= 0.154***	P< 0.000	1592.3	1332.3	133258.7
2.	Linearized Compound	139 439.7 NS	0.99 NS	-	-	R^2= 0.000 NS	P= 0.980	2725.4	2274.4	138343.0
3.	Linearized Inverse	28 9140**	5777 81011**	-	-	R^2= 0.057**	P= 0.008	1666.3	1435.4	141383.5
4.	Linearized Logarithmic	-217 8056**	286 586.3**	-	-	R^2= 0.057**	P= 0.008	1666.3	1435.4	141386.0
5.	Linearized Power	2.85 x10^{22} NS	-6.08 NS	-	-	R^2= 0.000 NS	P= 0.980	2725.4	2274.4	138347.0
6.	Linearized Exponential	139 439.7 NS	-0.003 NS	-	-	R^2= 0.000 NS	P= 0.980	2725.4	2274.4	138343.0
7.	Linearized Growth	11.8 NS	-0.003 NS	-	-	R^2= 0.000 NS	P= 0.980	2725.4	2274.4	138343.0
8.	Linearized S-curve	-0.31 NS	115 92.6 NS	-	-	R^2= 0.000 NS	P= 0.980	2725.4	2274.4	138351.0
9.	Exponential Smoothing	0.71	-	-	-	χ^2= 0.192	P< 0.000	1614.3	998.5	98755.1

10.	ARIMA (0,0,2) (2,1,0) [12]	-	-	-	-	χ^2 =0.009	P< 0.000 AIC= 1870.9	1238.1	802.8	63910.1

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.50, although many linearized models have significant R^2 values, the ARIMA(0,0,2)(2,1,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1870.9), as indicated above, among various models fitted apart from lowest error measures like RMSE (1238.1), MAE (802.8) and MAPE (63910.1). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Ghadghoda market.

4.13.1.4 Forecasting of Arrivals and Prices of Groundnut in Ghadghoda Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Ghadghoda market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.51 and also depitcted in graph in Fig 4.34.

Table 4.51: Forecasted values of Arrivals and Prices of Groundnut in Ghadghoda Market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	12.97	9.60	2064.11	1497.65
February	74.04	80.78	794.16	2075.97
March	0.00	0.00	0.00	0.00
April	0.00	0.00	0.00	0.00
May	0.00	0.00	726.80	271.42
June	193.87	148.75	3653.53	3738.37
July	179.23	184.62	3641.89	3834.09
August	338.40	367.36	3983.83	4082.93
September	114.80	116.15	3716.15	3883.03
October	80.70	59.76	2333.88	1565.08
November	162.62	154.67	4167.23	4174.60
December	46.71	34.59	2606.20	1662.74

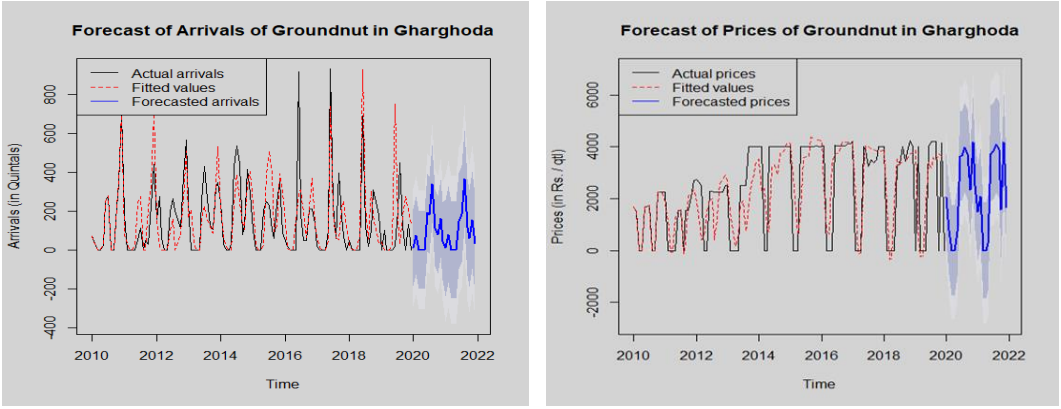


Fig. 4.34: Forecasts of Arrivals and Prices of Groundnut in Gharghoda Market

From the Table 4.13.1.3, the highest forecasted arrivals of groundnut for Gharghoda are expected to be 338.40 quintals and 367.36 quintals respectively in the month of August, 2020 and August, 2021 with respective forcasted prices to be Rs. 3983.83/quintal and Rs. 4082.93/quintal. However, the maximum prices were found to be Rs. 4167.23/quintal in the month of November, 2020 and Rs. 4174.60/quintal in the month of November, 2021.

4.14 Results for Arrivals and Prices of Oilseeds in Raigarh Market

4.14.1 Groundnut

4.14.1.1 Trend in Arrivals and Prices of Groundnut in Raigarh Market

Time series data for arrivals of groundnut in Raigarh has been presented in Fig. 4.35: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 816 quintals in June 2015 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut have also been plotted over the observed time series.

The linearized trend in the arrivals of groundnut in Raigarh has been indicated by dark-green line in the graph shown in Fig. 4.35: (e). It could be seen that the arrivals of groundnut in Raigarh had shown an increasing trend over the years.

Similarly time series data for prices of groundnut in Raigarh has been presented in Fig. 4.35: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4700 in December 2015 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Raigarh has been indicated by dark-green line in the graph shown in Fig. 4.35: (f). It could be seen that the prices of groundnut in Raigarh had shown an increasing trend over the years.

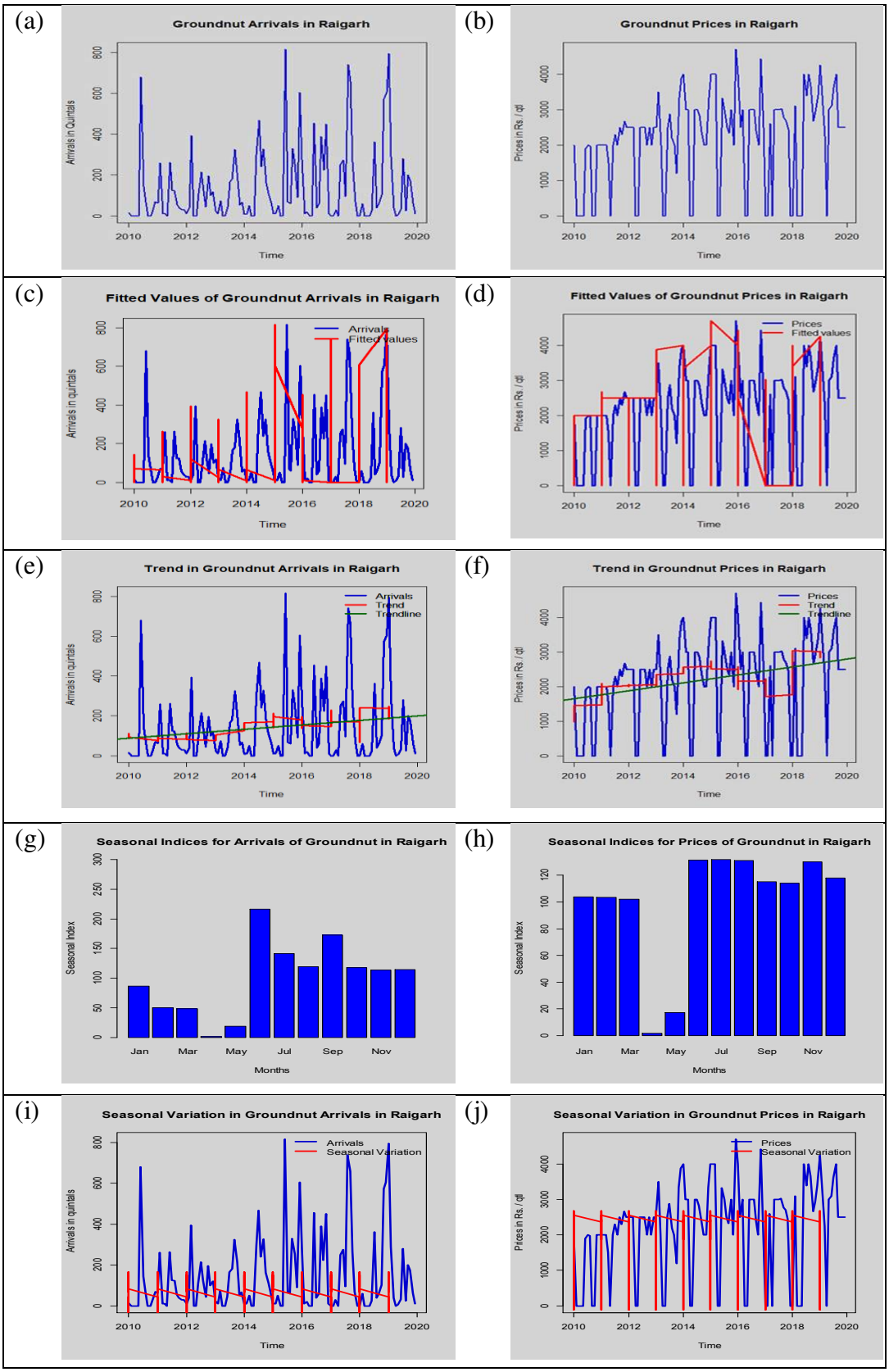


Fig. 4.35: Trend and Seasonality pattern in Arrivals and Prices of groundnut in Raigarh

4.14.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Raigarh Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.35: (g). The seasonal variation has been plotted in the graph of groundnut arrivals in Raigarh as shown there.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices has been shown in Fig. 4.35: (h). The seasonal variation has been plotted in the graph of groundnut prices in Raigarh.

4.14.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Raigarh Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Raigarh market were obtained as presented in the Table 4.52.

Table 4.52: Parameters of Fitted Model of Arrivals of Groundnut in Raigarh

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-22202.2$^{\$}$	11$^{\$}$	-	-	R^2= 0.028$^{\$}$	P= 0.064	187.1	139.4	6102.2
	2nd order	-763 6609$^{\$}$	7570.7^{NS}	-1.8^{NS}	-	R^2= 0.033$^{\$}$	P= 0.133	187.4	138.2	5990.0
	3rd order	82.4$^{\$}$	-1.7^{NS}	6.8^{NS}	-0.64^{NS}	R^2= 0.037$^{\$}$	P= 0.216	187.8	139.0	6193.7
2.	Linearized Compound	2.60 x10$^{-64\ NS}$	1.0^{NS}	-	-	R^2= 0.007^{NS}	P= 0.337	218.7	128.7	1336.4
3.	Linearized Inverse	22491.4$^{\$}$	-4502 9649$^{\$}$	-	-	R^2= 0.028$^{\$}$	P= 0.064	187.1	139.4	6101.8
4.	Linearized Logarithmic	-169 879$^{\$}$	22346.8$^{\$}$	-	-	R^2= 0.028$^{\$}$	P= 0.064	187.1	139.4	6102.0
5.	Linearized Power	0^{NS}	149.9^{NS}	-	-	R^2= 0.007^{NS}	P= 0.337	218.7	128.7	1336.4
6.	Linearized Exponential	2.60 x10$^{-64\ NS}$	0.07^{NS}	-	-	R^2= 0.007^{NS}	P= 0.337	218.7	128.7	1336.4
7.	Linearized Growth	-146.4^{NS}	0.07^{NS}	-	-	R^2= 0.007^{NS}	P= 0.337	218.7	128.7	1336.4
8.	Linearized S-curve	153.3$^{\$}$	-302 230.5$^{\$}$	-	-	R^2= 0.025$^{\$}$	P= 0.336	218.7	128.7	1336.4
9.	Exponential Smoothing	0.04	-	-	-	χ^2= 9.37	P< 0.000	191.4	134.1	1790.4

10.	ARIMA (1,0,0) (1,0,0) [12]	-	-	-	-	χ^2= 0.03	P< 0.000 AIC= 1590.8	176.6	123.4	1226.7
Note:- Polynomial models upto 3rd order are significant.										
Notations:-										
* Significant at 5% level of Significance										
** Significant at 1% level of Significance										
*** Significant at 0.1% level of Significance										
$ Significant at 10% level of Significance										

From the Table 4.52, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1590.8), as indicated above, among various models fitted apart from lowest error measures like RMSE (176.6), MAE (123.4) and MAPE (1226.7). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Raigarh market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Raigarh market were obtained as presented in the Table 4.53.

Table 4.53: Parameters of Fitted Model of Prices of Groundnut in Raigarh

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-229 903.7**	115.2**	-	-	R^2= 0.065**	P= 0.004	1264.6	976.7	92630.1
	2nd order	-1087 34632$	1078 39.2$	-26.7$	-	R^2= 0.087**	P= 0.004	1254.7	966.7	91026.2
	3rd order	1024.8**	912.2**	-189.6*	12.0$	R^2= 0.114**	P= 0.002	1241.5	960.6	87140.7
2.	Linearized Compound	1.13 x10-82$	1.1$	-	-	R^2= 0.006NS	P= 0.395	2170.4	1951.2	184713.0
3.	Linearized Inverse	234 410.8**	-4678 51760**	-	-	R^2= 0.065**	P= 0.004	1264.6	976.7	92625.6
4.	Linearized Logarithmic	-176 4113**	232 157.3**	-	-	R^2= 0.065**	P= 0.004	1264.6	976.7	92627.9
5.	Linearized Power	-	194.8$	-	-	R^2= 0.006NS	P= 0.395	2170.4	1951.2	184719.0
6.	Linearized Exponential	1.13 x10-82$	0.09$	-	-	R^2= 0.006NS	P= 0.395	2170.4	1951.2	184713.0
7.	Linearized Growth	188$	0.09$	-	-	R^2= 0.006NS	P= 0.395	2170.4	1951.2	184713.0
8.	Linearized S-curve	201$	-392 949.9$	-	-	R^2= 0.006NS	P= 0.395	2170.4	1951.2	184725.0

9.	Exponential Smoothing	0.05	-	-	-	χ^2= 16.29	P< 0.000	1289.6	1044.4	91543.2
10.	ARIMA (1,1,1) (2,0,0) [12]	-	-	-	-	χ^2= 0.004	P< 0.000 AIC= 2006.4	1036.4	792.7	50342.2

Note:- Polynomial models upto 3rd order are significant.

Notations:-

* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.53, although many linearized models have significant R^2 values, the ARIMA(1,1,1)(2,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2006.4), as indicated above, among various models fitted apart from lowest error measures like RMSE (1036.4), MAE (792.7) and MAPE (50342.2). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Raigarh market.

4.14.1.4 Forecasting of Arrivals and Prices of Groundnut in Raigarh Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Raigarh market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.54 and also depitcted in graph in Fig 4.36.

Table 4.54: Forecasted values of Arrivals and Prices of Groundnut in Raigarh Market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	183.45	144.42	2609.61	3055.55
February	143.09	137.77	3050.91	2986.28
March	115.00	133.14	1897.54	2332.70
April	112.42	132.71	1171.83	1543.59
May	114.79	133.10	2129.34	3077.34
June	119.35	133.85	3150.85	3258.75
July	160.45	140.63	3165.32	2707.57
August	118.28	133.68	3438.41	2628.39
September	147.14	138.43	2876.10	2650.82
October	142.86	137.73	2628.54	2686.45
November	124.56	134.71	2698.68	2592.50
December	115.99	133.30	2810.07	2943.98

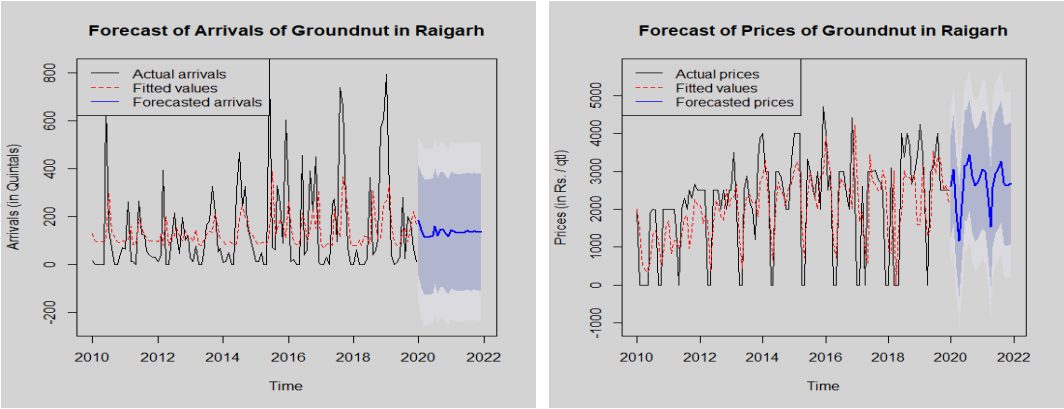


Fig. 4.36: Forecasts of Arrivals and Prices of Groundnut in Raigarh Market

From the Table 4.54, the highest forecasted arrivals of groundnut for Raigarh are expected to be 183.45 quintals and 144.42 quintals respectively in the month of January, 2020 and January, 2021 with respective forcasted prices to be Rs. 2609.61/quintal and Rs. 3055.55/quintal. However, the maximum prices were found to be Rs. 3438.41/quintal in the month of August, 2020 and Rs. 3258.75/quintal in the month of August, 2021.

4.15 Results for Arrivals and Prices of Oilseeds in Baikunthpur Market

4.15.1 Mustard

4.15.1.1 Trend in Arrivals and Prices of Mustard in Baikunthpur Market

Time series data for arrivals of mustard in Baikunthpur has been presented in Fig. 4.37: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 40 quintals in March 2015 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of mustard have also been plotted over the observed time series.

The linearized trend in the arrivals of mustard in Baikunthpur has been indicated by dark-green line in the graph shown in Fig. 4.37: (e). It could be seen that the arrivals of mustard in Baikunthpur had shown an increasing trend over the years.

Similarly time series data for prices of mustard in Baikunthpur has been presented in Fig. 4.37(b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4000 in November 2015 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of mustard have also been plottted.

The linearized trend in the prices of mustard in Baikunthpur has been indicated by dark-green line in the graph shown in Fig. 4.37: (f). It could be seen that the prices of mustard in Baikunthpur had shown an increasing trend over the years.

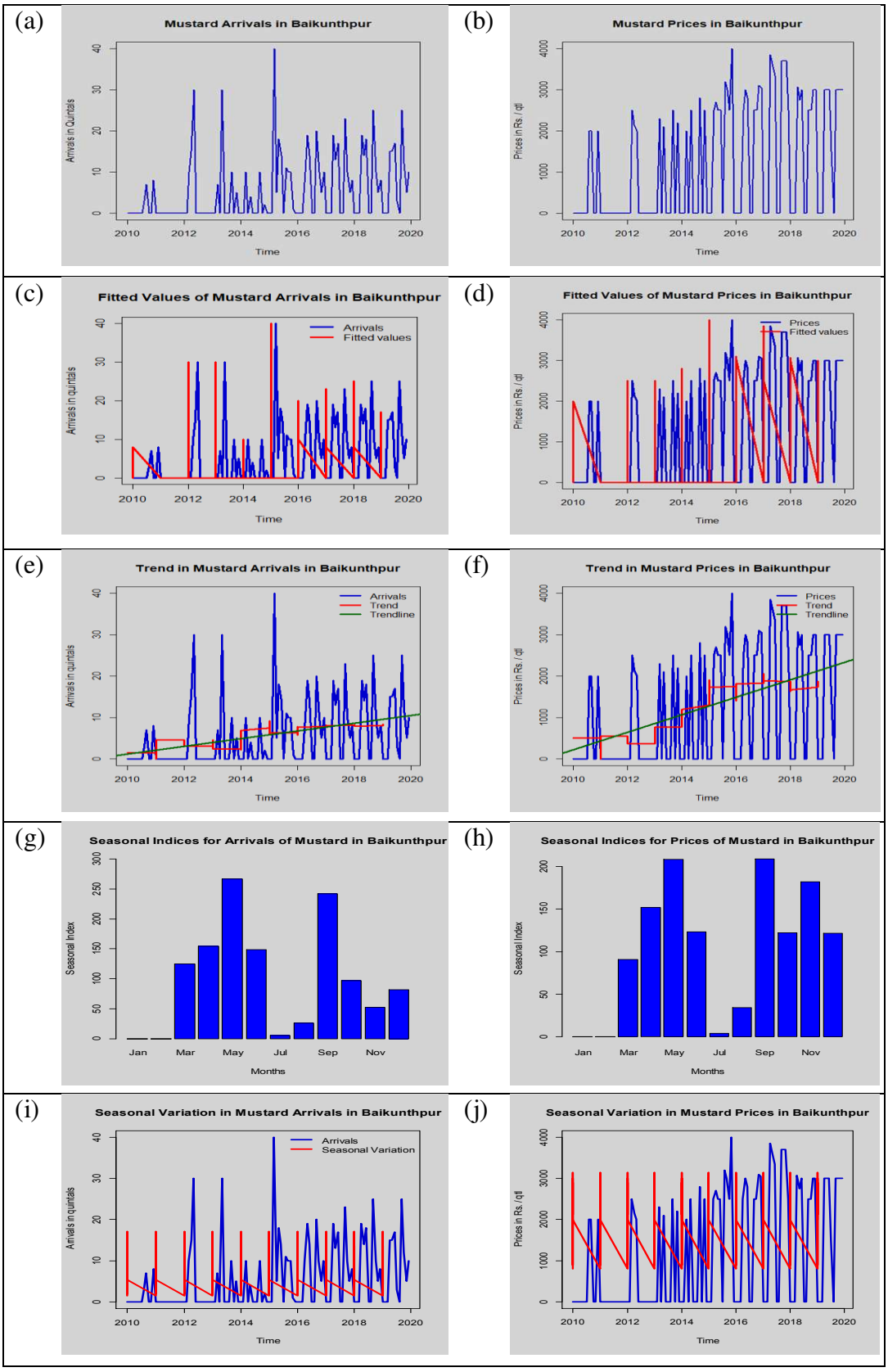


Fig. 4.37: Trend and Seasonality pattern in Arrivals and Prices of Mustard in Baikunthpur Market

4.15.1.2 Seasonality pattern in Arrivals and Prices of Mustard in Baikunthpur Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.37: (g). The seasonal variation has been plotted in the graph of mustard arrivals in Baikunthpur.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.37: (h). The seasonal variation is plotted in the graph of mustard prices in Baikunthpur.

4.15.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Mustard in Baikunthpur Market

By fitting different linear and non-linear time series models, we got following results for arrivals of mustard in Baikunthpur market were obtained as presented in the Table 4.55.

Table 4.55: Parameters of Fitted Model of Arrivals of Mustard in Baikunthpur

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-186 6.6***	0.9***	-	-	R^2= 0.109***	P< 0.000	7.6	5.6	545.6
	2nd order	-2478 18.3NS	24 5.1 NS	-0.0 NS	-	R^2= 0.112***	P< 0.000	7.6	5.6	544.0
	3rd order	1.0 NS	0.4 NS	0.2 NS	-0.02 NS	R^2= 0.114***	P= 0.002	7.7	5.6	540.0
2.	Linearized Compound	1.98 x10^{-184}***	1.2***	-	-	R^2= 0.149***	P< 0.000	8.4	5.3	235.8
3.	Linearized Inverse	187 7.8***	-3772 027***	-	-	R^2= 0.109***	P< 0.000	7.6	5.6	545.6
4.	Linearized Logarithmic	-1423 8.9***	187 2.2***	-	-	R^2= 0.109***	P< 0.000	7.6	5.6	545.6
5.	Linearized Power	-	42 3.6***	-	-	R^2= 0.149***	P< 0.000	8.4	5.3	235.8
6.	Linearized Exponential	1.98x 10^{-184}***	0.2***	-	-	R^2= 0.149***	P< 0.000	8.4	5.3	235.8
7.	Linearized Growth	-42 2.8***	0.2***	-	-	R^2= 0.149***	P< 0.000	8.4	5.3	235.8
8.	Linearized S-curve	424.2***	-8534 18.1***	-	-	R^2= 0.149***	P< 0.000	8.4	5.3	235.8
9.	Exponential Smoothing	0.05	-	-	-	χ^2=0.4	P< 0.000	7.9	5.4	407.3

10.	ARIMA (0,1,1) (1,0,0) [12]	-	-	-	-	χ^2=1.0	P< 0.000 AIC= 798.2	6.55	3.9	195.7
Note:- Polynomial models upto 3rd order are significant.										
Notations:-										
*	Significant at 5% level of Significance									
**	Significant at 1% level of Significance									
***	Significant at 0.1% level of Significance									
$	Significant at 10% level of Significance									

From the Table 4.55, although many linearized models have significant R^2 values, the ARIMA(0,1,1)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=798.2), as indicated above, among various models fitted apart from lowest error measures like RMSE (6.5), MAE (3.9) and MAPE (195.7). Thus, ARIMA model is chosen as best model for forecasting of mustard arrivals in Baikunthpur market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of mustard in Baikunthpur market were obtained as presented in the Table 4.56.

Table 4.56: Parameters of Fitted Model of Prices of Mustard in Baikunthpur

S. N.	**Models**	**α**	**β_1**	**β_2**	**β_3**	**R^2 / Test-Statistics**	**P-value / AIC**	**RMSE**	**MAE**	**MAPE**
1.	Linearized Polynomial 1st order	-426 435.4***	212.26***	-	-	R^2= 0.187***	P< 0.000	1278.4	1133.7	112346.9
	2nd order	-4770 0377NS	47146 NS	-11.6 NS	-	R^2= 0.191***	P< 0.000	1281.0	1127.1	111919.6
	3rd order	356.5 NS	-194 NS	138 NS	-11$	R^2= 0.210***	P< 0.000	1271.1	1103.7	110045.4
2.	Linearized Compound	0***	1.75***	-	-	R^2= 0.145***	P< 0.000	1793.4	1179.6	44932.0
3.	Linearized Inverse	428 852.6***	-8615 60565***	-	-	R^2= 0.187***	P< 0.000	1278.3	1133.6	112339.2
4.	Linearized Logarithmic	-325 2397***	427 644***	-	-	R^2= 0.187***	P< 0.000	1278.4	1133.6	112343.0
5.	Linearized Power	-	1137.7***	-	-	R^2= 0.145***	P< 0.000	1793.4	1179.6	44914.0
6.	Linearized Exponential	0***	0.56***	-	-	R^2= 0.145***	P< 0.000	1793.4	1179.6	44932.0
7.	Linearized Growth	-1134.6***	0.56***	-	-	R^2= 0.145***	P< 0.000	1793.4	1179.6	44932.0
8.	Linearized S-curve	1140.7***	-229 2120***	-	-	R^2= 0.145***	P< 0.000	1793.4	1179.7	44896.0

9.	Exponential Smoothing	0.07	-	-	-	χ^2= 5.03	P< 0.000	1310.3	1113.7	88854.7
10.	ARIMA (3,1,1) (1,0,0) [12]	-	-	-	-	χ^2= 0.02	P< 0.000 AIC= 1982.8	907.1	645.8	42278.0

Note:- Polynomial models upto 3rd order are significant.

Notations:-

* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.56, although many linearized models have significant R^2 values, the ARIMA(3,1,1)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1982.8), as indicated above, among various models fitted apart from lowest error measures like RMSE (907.1), MAE (645.8) and MAPE (42278.0). Thus, ARIMA model is chosen as best model for forecasting of mustard prices in Baikunthpur market.

4.15.1.4 Forecasting of Arrivals and Prices of Mustard in Baikunthpur Market

After identification of the model, forecasting of arrivals and prices of mustard has been done. The best ARIMA model has been used to forecast the arrivals and prices of mustard in Baikunthpur market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.57 and also depitcted in graph in Fig. 4.38.

Table 4.57: Forecasted values of Arrivals and Prices of Mustard in Baikunthpur Market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	3.88	5.99	651.04	1073.27
February	3.88	5.99	639.36	1065.36
March	3.88	5.99	587.30	1029.64
April	12.02	10.41	2674.18	2460.63
May	12.02	10.41	2673.38	2460.07
June	13.11	11.00	2685.91	2468.66
July	5.51	6.87	1655.52	1762.12
August	3.88	5.99	628.83	1058.12
September	17.45	13.36	2684.16	2467.46
October	10.39	9.53	2684.37	2467.60
November	6.59	7.46	2683.85	2467.24
December	9.31	8.94	2684.03	2467.37

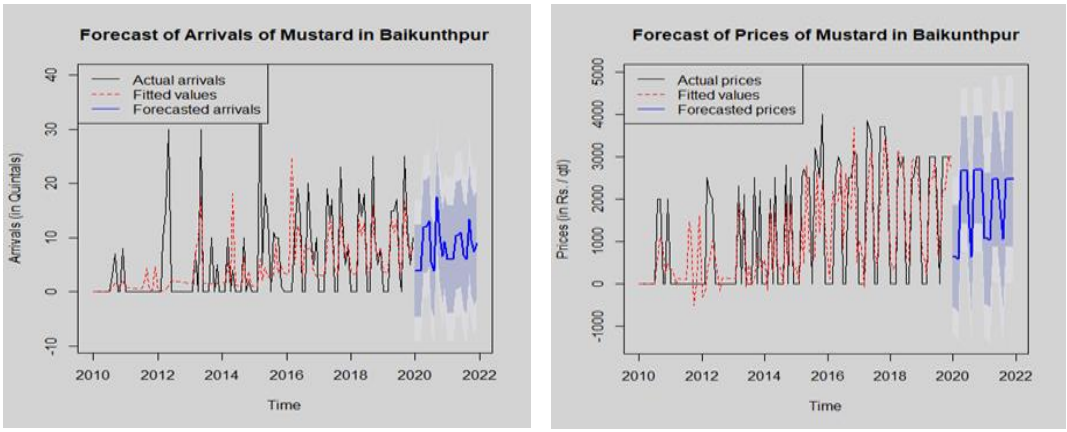


Fig. 4.38: Forecasts of Arrivals and Prices of Mustard in Baikunthpur Market

From the Table 4.57, the highest forecasted arrivals of mustard for Baikunthpur are expected to be 17.45 quintals and 13.36 quintals respectively in the month of September, 2020 and September, 2021 with respective forcasted prices to be Rs. 2594.80/quintal and Rs. 2590.24/quintal. However, the maximum prices were found to be Rs. 2684.37/quintal in the month of October, 2020 and Rs. 2468.66/quintal in the month of June, 2021.

4.16 Results for Arrivals and Prices of Oilseeds in Patthalgaon Market

4.16.1 Groundnut

4.16.1.1 Trend in Arrivals and Prices of Groundnut in Patthalgaon Market

Time series data for arrivals of groundnut in Patthalgaon has been presented in Fig. 4.39: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 1308 quintals in November 2013 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut have also been plotted over the observed time series.

The linearized trend in the arrivals of groundnut in Patthalgaon has been indicated by dark-green line in the graph shown in Fig. 4.39: (e). It could be seen that the arrivals of groundnut in Patthalgaon had shown an increasing trend over the years.

Similarly time series data for prices of groundnut in Patthalgaon has been presented in Fig. 4.39: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 5000 in February 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Patthalgaon has been indicated by dark-green line in the graph shown in Fig. 4.39: (f). It could be seen that the prices of groundnut in Patthalgaon had shown an increasing trend over the years.

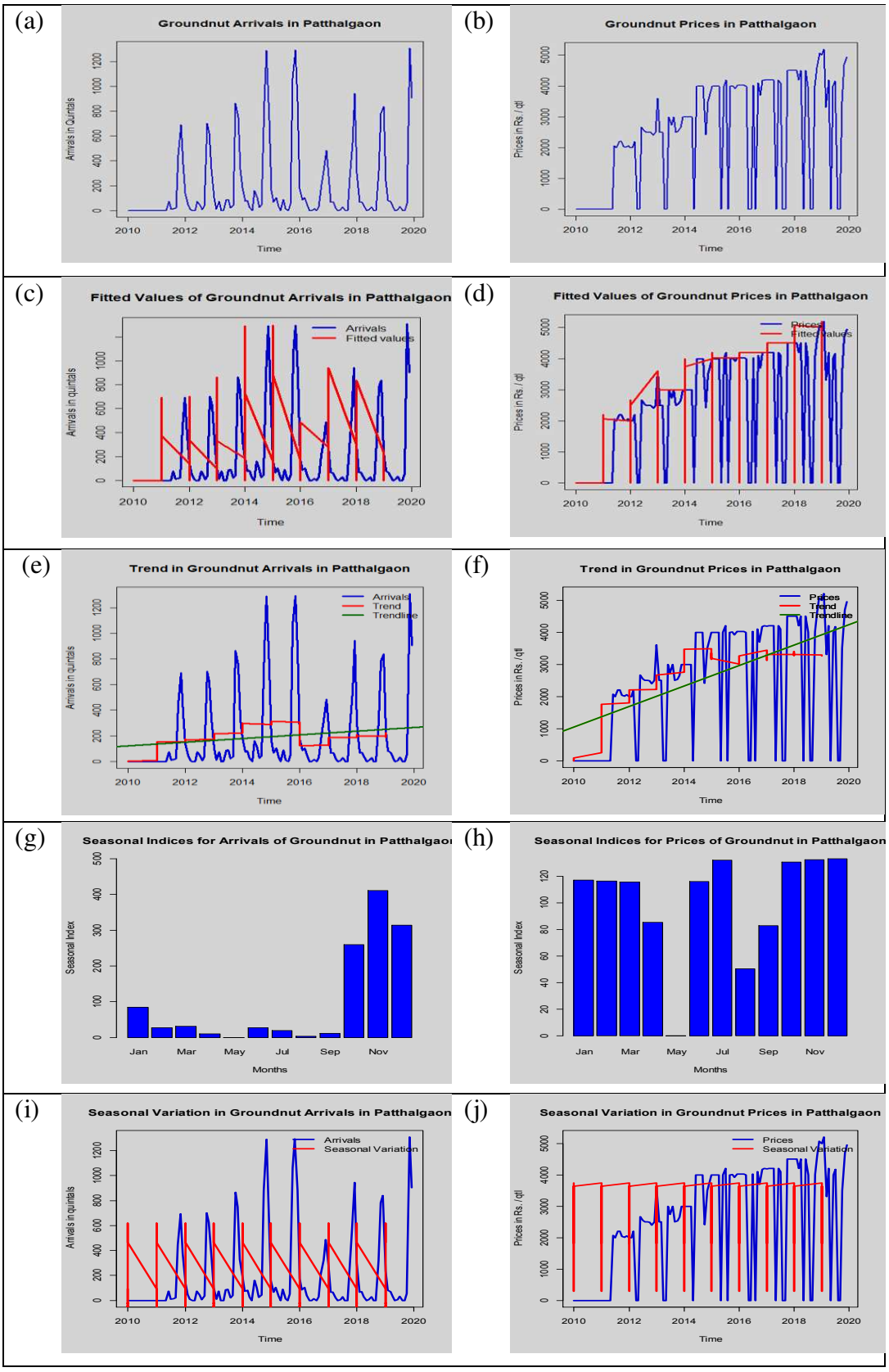


Fig. 4.39: Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Patthalgaon Market

4.16.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Patthalgaon Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.39: (g). The seasonal variation is plotted in the graph of groundnut arrivals in Patthalgaon.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.35: (h). The seasonal variation is plotted in the graph of groundnut prices in Patthalgaon.

4.16.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Patthalgaon Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Patthalgaon market were obtained as presented in the Table 4.58.

Table 4.58: Parameters of Fitted Model of Arrivals of Groundnut in Patthalgaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-28 958.5^{NS}	14.46^{NS}	-	-	R^2= 0.017^{NS}	P= 0.148	313.0	222.6	10364.3
	2nd order	-264 91305$^{\$}$	26286.4$^{\$}$	-6.5$^{\$}$	-	R^2= 0.040$^{\$}$	P= 0.089	310.7	219.1	8763.0
	3rd order	-7.9*	164.2^{NS}	-33.1^{NS}	1.9^{NS}	R^2= 0.052$^{\$}$	P= 0.097	310.0	218.6	8251.6
2.	Linearized Compound	1.85 x10^{-210*}	1.27*	-	-	R^2= 0.064*	P= 0.005	353.1	179.8	1367.1
3.	Linearized Inverse	293 70.57^{NS}	-587 93844^{NS}	-	-	R^2= 0.017^{NS}	P= 0.148	313.0	222.6	10361.0
4.	Linearized Logarithmic	-291 702.3^{NS}	29 164.5^{NS}	-	-	R^2= 0.017^{NS}	P= 0.148	313.0	222.6	10362.7
5.	Linearized Power	-	486.38*	-	-	R^2= 0.064*	P= 0.005	353.1	179.8	1367.2
6.	Linearized Exponential	1.85 x10^{-210*}	0.24*	-	-	R^2= 0.064*	P= 0.005	353.1	179.8	1367.1
7.	Linearized Growth	-482.92*	0.24*	-	-	R^2= 0.064*	P= 0.005	353.1	179.8	1367.1
8.	Linearized S-curve	489.84*	-80677.4*	-	-	R^2= 0.064*	P= 0.005	353.1	179.8	1367.4
9.	Exponential Smoothing	0.99	-	-	-	χ^2= 2.26	P< 0.000	270.0	145.1	749.5

10.	ARIMA (0,0,2) (0,1,0) [12]	-	-	-	-	χ^2= 0.004	P< 0.000 AIC= 1413.6	155.0	73.2	475.9

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.58, although many linearized models have significant R^2 values, the ARIMA(0,0,2)(0,1,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1413.6), as indicated above, among various models fitted apart from lowest error measures like RMSE (155.0), MAE (73.2) and MAPE (475.9). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Patthalgaon market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Patthalgaon market were obtained as presented in the Table 4.59.

Table 4.59: Parameters of Fitted Model of Prices of Groundnut in Patthalgaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-638004.2***	317.93***	-	-	R^2= 0.261***	P< 0.000	1548.8	1279.3	126241.8
	2nd order	-2872 19800***	284 837.6***	9.43***	-	R^2= 0.343***	P< 0.000	1466.1	1095.8	108819.7
	3rd order	9.4NS	1311.8**	-175.5$	7.7NS	R^2= 0.349***	P< 0.000	1465.8	1067.9	105491.8
2.	Linearized Compound	0***	1.54***	-	-	R^2= 0.094***	P< 0.000	2639.1	2274.2	231667.0
3.	Linearized Inverse	643 421.2***	-12911 66424***	-	-	R^2= 0.261***	P< 0.000	1548.5	1278.7	126186.7
4.	Linearized Logarithmic	-4872 139***	640 712.6***	-	-	R^2= 0.261***	P< 0.000	1548.5	1278.7	126214.2
5.	Linearized Power	-	874.7***	-	-	R^2= 0.094***	P< 0.000	2639.1	2274.2	231769.2
6.	Linearized Exponential	0***	0.43***	-	-	R^2= 0.094***	P< 0.000	2639.1	2274.2	231667.0
7.	Linearized Growth	-868.5***	0.43***	-	-	R^2= 0.094***	P< 0.000	2639.1	2274.2	231667.0
8.	Linearized S-curve	880.8***	-176 3400***	-	-	R^2= 0.094***	P< 0.000	2639.1	2274.2	231870.0
9.	Exponential Smoothing	0.12	-	-	-	χ^2= 2.75	P< 0.000	1535.5	1183.3	95417.2

10.	ARIMA (1,1,1) (0,1,1) [12]	-	-	-	-	χ^2= 0.08	P< 0.000 AIC= 1796.5	962.8	541.0	40749.7

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.59, although many linearized models have significant R^2 values, the ARIMA(1,1,1)(0,1,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1796.5), as indicated above, among various models fitted apart from lowest error measures like RMSE (962.8), MAE (541.0) and MAPE (40749.7). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Patthalgaon market.

4.16.1.4 Forecasting of Arrivals and Prices of Groundnut in Patthalgaon Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Patthalgaon market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.60 and also depitcted in graph in Fig 4.40.

Table 4.60: Forecasted values of Arrivals and Prices of Groundnut in Patthalgaon Market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	186.78	186.78	4862.10	4857.58
February	20.83	20.83	5010.06	5006.67
March	70.00	70.00	3506.77	3503.56
April	32.00	32.00	4246.25	4243.07
May	0.00	0.00	0.00	0.00
June	8.00	8.00	4053.87	4050.71
July	32.00	32.00	4127.73	4124.56
August	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00
October	55.00	55.00	3634.10	3630.93
November	1308.00	1308.00	4660.76	4657.59
December	904.00	904.00	4933.19	4930.02

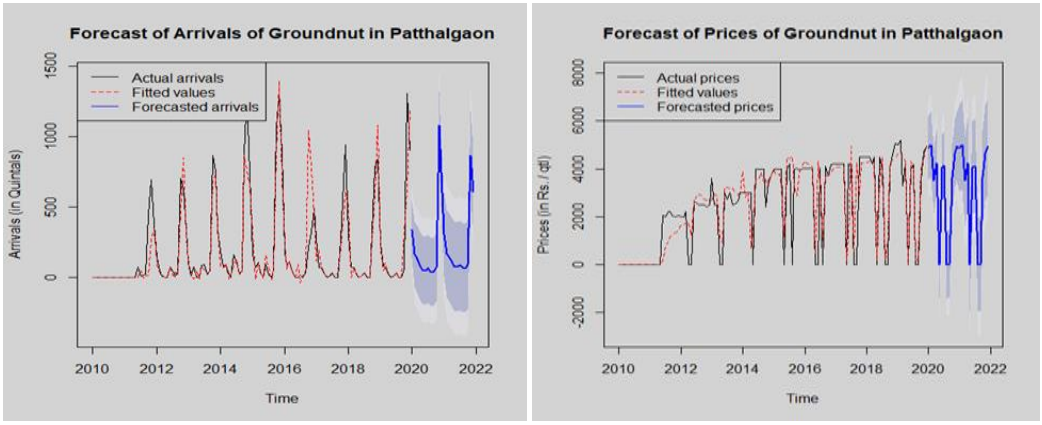


Fig. 4.40: Forecasts of Arrivals and Prices of Groundnut in Patthalgaon

From the Table 4.60, the highest forecasted arrivals of groundnut for Patthalgaon are expected to be 1308.00 quintals and 1308.00 quintals respectively in the month of November, 2020 and November, 2021 with respective forcasted prices to be Rs. 4660.76/quintal and Rs. 4657.59/quintal. However, the maximum prices were found to be Rs. 5010.06/quintal in the month of February, 2020 and Rs. 5006.67/quintal in the month of February, 2021.

4.16.2 Mustard

4.16.2.1 Trend in Arrivals and Prices of Mustard in Patthalgaon Market

Time series data for arrivals of mustard in Patthalgaon has been presented in Fig. 4.41: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 175 quintals in March 2012 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of mustard have also been plotted over the observed time series.

The linearized trend in the arrivals of mustard in Patthalgaon has been indicated by dark-green line in the graph shown in Fig. 4.41: (e). It could be seen that the arrivals of mustard in Patthalgaon had shown an increasing trend over the years.

Similarly time series data for prices of mustard in Patthalgaon has been presented in Fig. 4.41: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4500 in September 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of mustard have also been plottted.

The linearized trend in the prices of mustard in Patthalgaon has been indicated by dark-green line in the graph shown in Fig. 4.41: (f). It could be seen that the prices of mustard in Patthalgaon had shown an increasing trend over the years.

4.16.2.2 Seasonality pattern in Arrivals and Prices of Mustard in Patthalgaon Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal

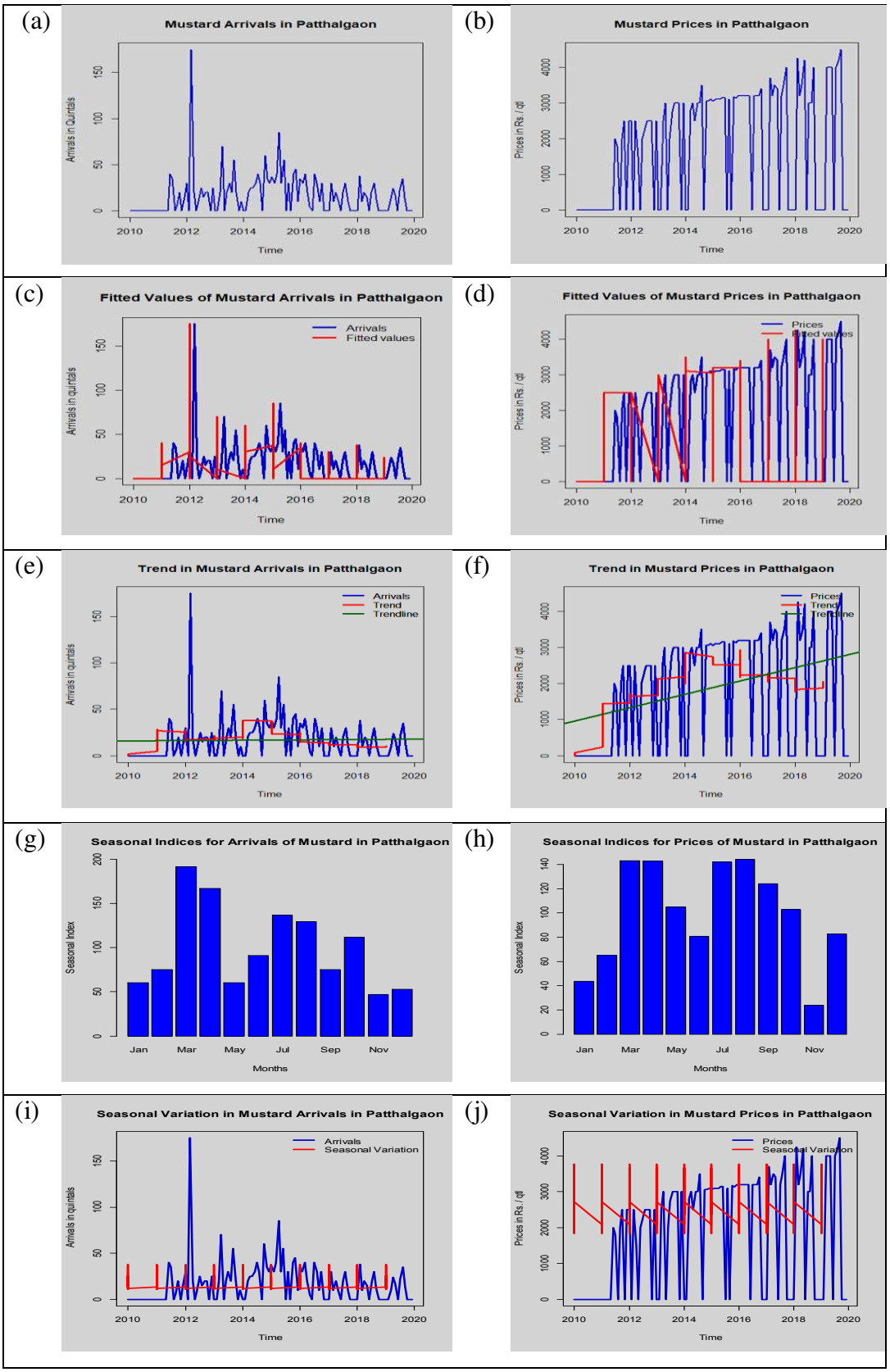


Fig. 4.41: Trend and Seasonality pattern in Arrivals and Prices of mustard in Patthalgaon

indices as shown in Fig. 4.41: (g). The seasonal variation is plotted in the graph of mustard arrivals in Patthalgaon as shown there.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.41: (h). The seasonal variation is plotted in the graph of mustard prices in Patthalgaon as shown there.

4.16.2.3 Identifying the Best Forecasting Model for Arrivals and Prices of Mustard in Patthalgaon Market

By fitting different linear and non-linear time series models, we got following results for arrivals of mustard in Patthalgaon market were obtained as presented in the Table 4.61.

Table 61: Parameters of Fitted Model of Arrivals of Mustard in Patthalgaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-324.8^{NS}	0.16^{NS}	-	-	$R^2=0.000^{NS}$	P= 0.815	22.7	15.7	1432.7
	2nd order	$-442\,8735^{***}$	4396.7^{***}	-1.0^{***}	-	$R^2=0.123^{***}$	P< 0.000	21.4	13.2	1131.0
	3rd order	-1.3^{NS}	18.1^{**}	-3.4^{*}	0.1^{NS}	$R^2=0.142^{***}$	P< 0.000	21.2	13.3	1139.8
2.	Linearized Compound	$8.56 \times 10^{-91\,NS}$	$1.10^{\$}$	-	-	$R^2=0.023^{\$}$	P= 0.097	25.8	16.2	4402.0
3.	Linearized Inverse	365.8^{NS}	$-702\,737.9^{NS}$	-	-	$R^2=0.000^{NS}$	P= 0.811	22.7	15.7	1432.5
4.	Linearized Logarithmic	-2610.4^{NS}	345.3^{NS}	-	-	$R^2=0.000^{NS}$	P= 0.811	22.7	15.7	1432.6
5.	Linearized Power	-	$209.3^{\$}$	-	-	$R^2=0.023^{\$}$	P= 0.097	25.8	15.7	4402.0
6.	Linearized Exponential	$8.56 \times 10^{-91\,NS}$	$0.10^{\$}$	-	-	$R^2=0.023^{\$}$	P= 0.097	25.8	15.7	4402.0
7.	Linearized Growth	-207.3^{NS}	$0.10^{\$}$	-	-	$R^2=0.023^{\$}$	P= 0.097	25.8	15.7	4402.0
8.	Linearized S-curve	211.2^{NS}	$-422\,392.4^{\$}$	-	-	$R^2=0.023^{\$}$	P= 0.097	25.8	15.7	4402.0
9.	Exponential Smoothing	0.10	-	-	-	$\chi^2=0.01$	P< 0.000	22.1	13.1	1001.3
10.	ARIMA (1,0,1) (1,0,1) [12]	-	-	-	-	$\chi^2=0.06$	P< 0.000 AIC= 1092.1	21.7	13.8	991.7

Note:- Polynomial models upto 3rd order are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.61, although many linearized models have significant R^2 values, the ARIMA(1,0,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1092.1), as indicated above, among various models fitted apart from lowest error measures like RMSE (21.7), MAE (13.8) and MAPE (991.7). Thus, ARIMA model is chosen as best model for forecasting of mustard arrivals in Patthalgaon market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of mustard in Patthalgaon market were obtained as presented in the Table 4.62.

Table 4.62: Parameters of Fitted Model of Prices of Mustard in Patthalgaon

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-370318.8***	184.7***	-	-	R^2= 0.111***	P< 0.000	1507.2	1400.9	140114.4
	2nd order	-272005967***	269865.7***	-66.9***	-	R^2= 0.205***	P< 0.000	1431.3	1215.7	121592.3
	3rd order	-21.1 NS	1120.5**	-164.5 NS	7.2 NS	R^2= 0.212***	P< 0.000	1431.6	1204.7	120620.7
2.	Linearized Compound	2.75 x10^{-263}*	1.35*	-	-	R^2= 0.040*	P= 0.026	2319.0	1801.9	90809.0
3.	Linearized Inverse	3743 37.4***	-7504 83880***	-	-	R^2= 0.112***	P< 0.000	1507.0	1400.5	140078.0
4.	Linearized Logarithmic	-283 0923***	372 328.1***	-	-	R^2= 0.112***	P< 0.000	1507.0	1400.5	140096.2
5.	Linearized Power	-	609.6*	-	-	R^2= 0.040*	P= 0.026	23199.5	1801.9	90857.0
6.	Linearized Exponential	2.75 x10^{-263}*	0.30*	-	-	R^2= 0.040*	P= 0.026	23199.5	1801.9	90809.0
7.	Linearized Growth	-604.5*	0.30*	-	-	R^2= 0.040*	P= 0.026	23199.5	1801.9	90809.0
8.	Linearized S-curve	614.7*	122 9624*	-	-	R^2= 0.040*	P= 0.026	23199.0	1801.9	90905.0
9.	Exponential Smoothing	0.10	-	-	-	χ^2= 2.61	P< 0.000	1485.2	1254.4	90872.8
10.	ARIMA (1,1,1) (1,0,0) [12]	-	-	-	-	χ^2= 0.02	P< 0.000 AIC= 2040.3	1200.7	864.2	76791.4

Note:- Polynomial models upto 3rd order are significant.

Notations:-

*	Significant at 5% level of Significance
**	Significant at 1% level of Significance
***	Significant at 0.1% level of Significance
$	Significant at 10% level of Significance

From the Table 4.62, although many linearized models have significant R^2 values, the ARIMA(1,1,1)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2040.3), as indicated above, among various models fitted apart from lowest error measures like RMSE (1200.7), MAE (864.2) and MAPE (76791.4). Thus, ARIMA model is chosen as best model for forecasting of mustard prices in Patthalgaon market.

4.16.2.3 Forecasting of Arrivals and Prices of Mustard in Patthalgaon Market

After identification of the model, forecasting of arrivals and prices of mustard has been done. The best ARIMA model has been used to forecast the arrivals and prices of mustard in Patthalgaon market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.63 and also depitcted in graph in Fig 4.42.

Table 4.63: Forecasted values of Arrivals and Prices of Mustard in Patthalgaon Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	9.73	12.26	679.80	1214.01
February	12.01	13.54	797.69	1281.91
March	11.85	13.43	3122.24	2620.91
April	13.83	14.54	3125.78	2622.96
May	12.56	13.80	3126.40	2623.31
June	10.61	12.69	822.39	1296.14
July	14.00	14.60	3126.52	2623.38
August	15.85	15.64	3241.73	2689.74
September	12.75	13.86	3414.54	2789.29
October	11.49	13.14	822.42	1296.15
November	11.26	13.00	822.42	1296.15
December	11.23	12.97	822.42	1296.15

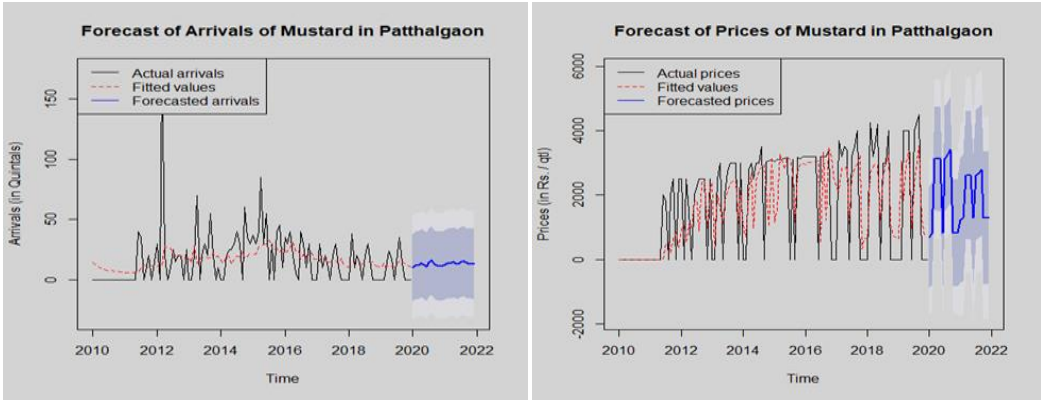


Fig. 4.42: Forecasts of Arrivals and Prices of Mustard in Patthalgaon Market

From the Table 4.63, the highest forecasted arrivals of mustard for Patthalgaon are expected to be 15.85 quintals and 15.64 quintals respectively in the month of August, 2020 and August, 2021 with respective forcasted prices to be Rs. 3241.73/quintal and Rs. 2689.29/quintal. However, the maximum prices were found to be Rs. 3414.54/quintal in the month of September, 2020 and Rs. 2789.74/quintal in the month of September, 2021.

4.17 Results for Arrivals and Prices of Oilseeds in Jashpurnagar Market

4.17.1 Groundnut

4.17.1.1 Trend in Arrivals and Prices of Groundnut in Jashpurnagar Market

Time series data for arrivals of groundnut in Jashpurnagar has been presented in Fig. 4.43: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 1352 quintals in November 2014 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut have also been plotted over the observed time series.

The linearized trend in the arrivals of groundnut in Jashpurnagar has been indicated by dark-green line in the graph shown in Fig. 4.43: (e). It could be seen that the arrivals of groundnut in Jashpurnagar had shown an increasing trend over the years.

Similarly time series data for prices of groundnut in Jashpurnagar has been presented in Fig. 4.43: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 5000 in January 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Jashpurnagar has been indicated by dark-green line in the graph shown in Fig. 4.43: (f). It could be seen that the prices of groundnut in Jashpurnagar had shown an increasing trend over the years.

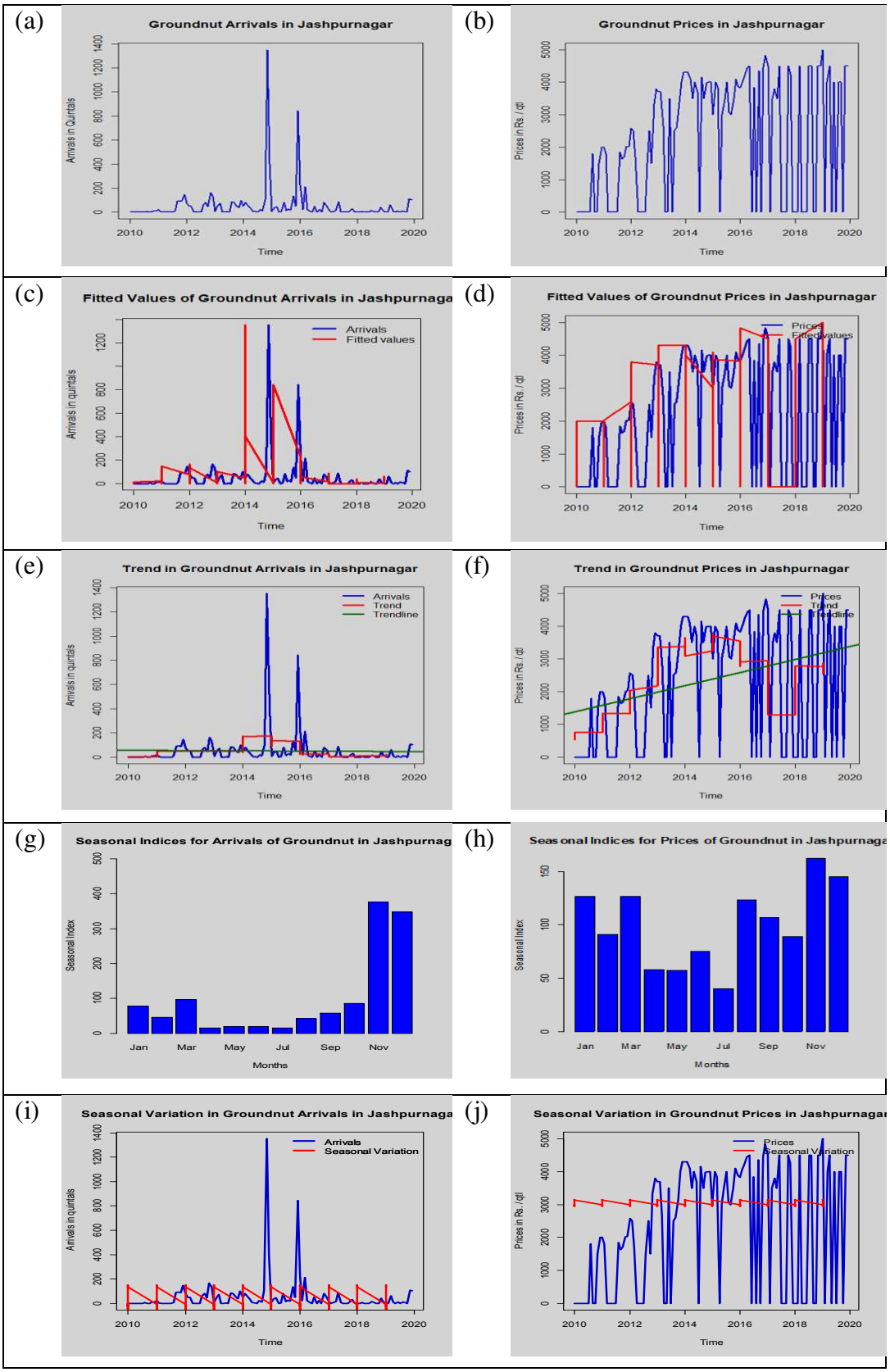


Fig. 4.43: Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Jashpurnagar

4.17.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Jashpurnagar Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.43: (g). The seasonal variation is plotted in the graph of groundnut arrivals in Jashpurnagar.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.43: (h). The seasonal variation is plotted in the graph of groundnut prices in Jashpurnagar.

4.17.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Jashpurnagar Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Jashpurnagar market were obtained as presented in the Table 4.17.1.1.

Table 4.64: Parameters of Fitted Model of Arrivals of Groundnut in Jashpurnagar

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	2845.8^{NS}	-1.3^{NS}	-	-	R^2= 0.000^{NS}	P= 0.774	152.1	62.2	3868.5
	2nd order	-1893 5430^{NS}	18800.6^{NS}	-4.6^{NS}	-	R^2= 0.051*	P= 0.046	148.8	60.8	2988.0
	3rd order	-13.09^{NS}	68.6$^{\$}$	-12.8^{NS}	0.6^{NS}	R^2= 0.056*	P= 0.080	149.1	60.3	3067.6
2.	Linearized Compound	237.7^{NS}	0.9^{NS}	-	-	R^2= 0.000^{NS}	P= 0.980	158.7	51.3	5542.0
3.	Linearized Inverse	-2711.9^{NS}	556 7987^{NS}	-	-	R^2= 0.000^{NS}	P= 0.777	152.1	62.2	3868.4
4.	Linearized Logarithmic	21194.2^{NS}	-2778.9^{NS}	-	-	R^2= 0.000^{NS}	P= 0.775	152.1	62.2	3868.5
5.	Linearized Power	-	-3.1^{NS}	-	-	R^2= 0.000^{NS}	P= 0.982	158.7	51.3	5542.0
6.	Linearized Exponential	273.7^{NS}	-0.001^{NS}	-	-	R^2= 0.000^{NS}	P= 0.980	158.7	51.3	5542.0
7.	Linearized Growth	5.4^{NS}	-0.001^{NS}	-	-	R^2= 0.000^{NS}	P= 0.980	158.7	51.3	5542.0
8.	Linearized S-curve	-0.7^{NS}	5530.6^{NS}	-	-	R^2= 0.000^{NS}	P= 0.984	158.7	51.3	5541.0
9.	Exponential Smoothing	0.06	-	-	-	χ^2= 6.68	P< 0.000	151.8	62.3	2613.8

10.	ARIMA (0,0,1) (1,0,1) [12]	-	-	-	-	χ^2= 0.0002	P< 0.000 AIC= 1543	142.3	52.1	2901.3
Note:- Polynomial models upto 3rd order are significant.										
Notations:-										
* Significant at 5% level of Significance										
** Significant at 1% level of Significance										
*** Significant at 0.1% level of Significance										
$ Significant at 10% level of Significance										

From the Table 4.64, although many linearized models have significant R^2 values, the ARIMA(0,0,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1543), as indicated above, among various models fitted apart from lowest error measures like RMSE (142.3), MAE (52.1) and MAPE (2901.3). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Jashpurnagar market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Jashpurnagar market were obtained as presented in the Table 4.65.

Table 4.65: Parameters of Fitted Model of Prices of Groundnut in Jashpurnagar

S. N.	**Models**	**α**	**β_1**	**β_2**	**β_3**	**R^2 / Test-Statistics**	**P-value / AIC**	**RMSE**	**MAE**	**MAPE**
1.	Linearized Polynomial									
	1st order	-399 996.2***	199.69***	-	-	R^2= 0.096***	P< 0.000	1771.8	1567.8	155708.0
	2nd order	-3508 13582***	348 091.8***	-86.34***	-	R^2= 0.211***	P< 0.000	1662.1	1387.5	136422.8
	3rd order	119NS	1401.3**	-210.6$	9.2NS	R^2= 0.219***	P< 0.000	1661.1	1373.3	133908.7
2.	Linearized Compound	6.50x 10^{-145}NS	1.18 NS	-	-	R^2= 0.013 NS	P= 0.214	2820.2	2270.9	119600.0
3.	Linearized Inverse	405 119.5***	-81150 6655***	-	-	R^2= 0.096***	P< 0.000	1771.6	1567.7	155679.9
4.	Linearized Logarithmic	-306 0424***	402 55.8***	-	-	R^2= 0.096***	P< 0.000	1771.6	1567.7	155694.0
5.	Linearized Power	-	337.6 NS	-	-	R^2= 0.013 NS	P= 0.214	2820.2	2270.9	119639.0
6.	Linearized Exponential	6.50x 10^{-145} NS	0.16 NS	-	-	R^2= 0.013 NS	P= 0.214	2820.2	2270.9	119600.0
7.	Linearized Growth	-332 NS	0.16 NS	-	-	R^2= 0.013 NS	P= 0.214	2820.2	2270.9	119600.0
8.	Linearized S-curve	343.2 NS	-681 435.5 NS	-	-	R^2= 0.013 NS	P= 0.214	2820.2	2270.9	119677.0

9.	Exponential Smoothing	0.13	-	-	-	χ^2= 0.11	P< 0.000	1698.5	1410.3	117939.6
10.	ARIMA (2,1,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.03	P< 0.000 AIC= 2116.7	1625.1	1295.1	117862.0

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.65, although many linearized models have significant R^2 values, the ARIMA(2,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2116.7), as indicated above, among various models fitted apart from lowest error measures like RMSE (1625.1), MAE (1295.1) and MAPE (117862.0). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Jashpurnagar market.

4.17.1.4 Forecasting of Arrivals and Prices of Groundnut in Jashpurnagar Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Jashpurnagar market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.66 and also depitcted in graph in Fig 4.44.

Table 4.66: Forecasted values of Arrivals and Prices of Groundnut in Jashpurnagar Market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	48.78	48.09	3274.24	3407.22
February	42.60	42.67	2372.55	2644.94
March	51.39	51.40	3437.66	3546.16
April	37.50	37.61	2780.69	2889.18
May	38.39	38.50	2472.82	2599.56
June	38.30	38.41	2829.25	2938.39
July	37.61	37.72	2430.96	2566.82
August	42.00	42.08	3010.26	3109.63
September	44.56	44.61	2833.54	2943.79
October	49.26	49.28	2512.85	2643.20
November	98.30	97.94	3829.62	3877.19
December	92.99	92.67	3567.94	3631.97

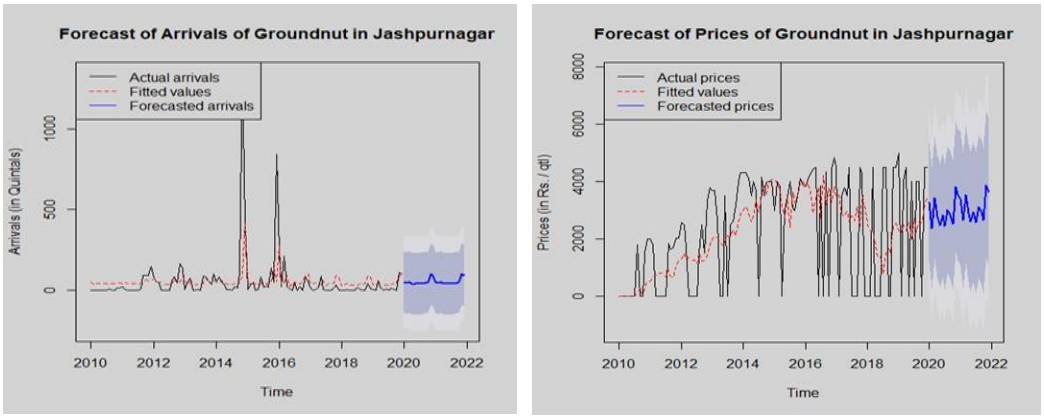


Fig. 4.44: Forecasts of Arrivals and Prices of Groundnut in Jashpurnagar

From the Table 4.66, the highest forecasted arrivals of groundnut for Jashpurnagar are expected to be 98.30 quintals and 97.94 quintals respectively in the month of November, 2020 and November, 2021 with respective forcasted prices to be Rs. 3829.62/quintal and Rs. 3877.19/quintal. However, the maximum prices were found to be Rs. 3829.62/quintal in the month of September, 2020 and Rs. 3877.19/quintal in the month of September, 2021.

4.17.2 Sesame

4.17.2.1 Trend in Arrivals and Prices of Sesame in Jashpurnagar Market

Time series data for arrivals of sesame in Jashpurnagar has been presented in Fig. 4.45: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 3160 quintals in February 2011 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of sesame have also been plotted over the observed time series.

The linearized trend in the arrivals of sesame in Jashpurnagar has been indicated by dark-green line in the graph shown in Fig. 4.45: (e). It could be seen that the arrivals of sesame in Jashpurnagar had shown a decreasing trend over the years.

Similarly time series data for prices of sesame in Jashpurnagar has been presented in Fig. 4.45: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 5200 in December 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of sesame have also been plottted.

The linearized trend in the prices of sesame in Jashpurnagar has been indicated by dark-green line in the graph shown in Fig. 4.45: (f). It could be seen that the prices of sesame in Jashpurnagar had shown an increasing trend over the years.

4.17.2.2 Seasonality pattern in Arrivals and Prices of Sesame in Jashpurnagar Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.45: (g). The seasonal variation is plotted in the graph of sesame arrivals in Jashpurnagar as shown there.

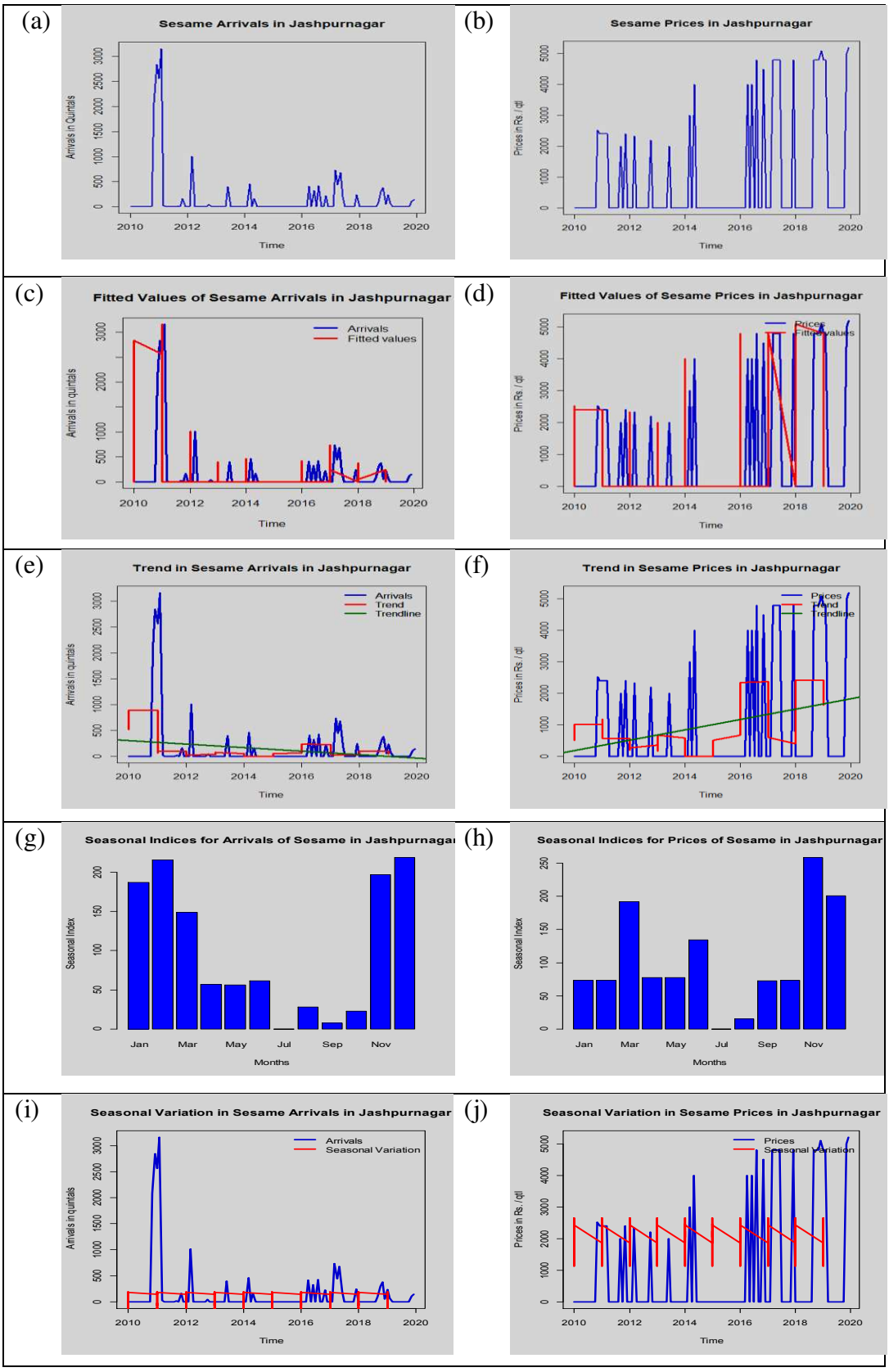


Fig. 4.45: Trend and Seasonality pattern in Arrivals and Prices of sesame in Jashpurnagar Market

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.45: (h). The seasonal variation is plotted in the graph of sesame prices in Jashpurnagar.

4.17.2.3 Identifying the Best Forecasting Model for Arrivals and Prices of Sesame in Jashpurnagar Market

By fitting different linear and non-linear time series models, we got following results for arrivals of sesame in Jashpurnagar market were obtained as presented in the Table 4.67.

Table 4.67: Parameters of Fitted Model of Arrivals of Sesame in Jashpurnagar Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	67722.8*	-33.54*	-	-	R^2= 0.037*	P= 0.034	493.1	249.6	23694.4
	2nd order	45192162$	-44833.2$	11.1$	-	R^2= 0.063*	P= 0.021	488.4	244.2	22772.7
	3rd order	506.6***	-266.4*	50*	-2.8*	R^2= 0.073*	P= 0.029	487.8	238.8	22549.5
2.	Linearized Compound	2.88 x10^{-65} NS	1.07 NS	-	-	R^2= 0.005 NS	P= 0.405	542.1	153.3	37520.0
3.	Linearized Inverse	-67494.62*	1362 69069*	-	-	R^2= 0.037*	P= 0.034	493.1	249.6	23693.0
4.	Linearized Logarithmic	514525.4*	-67608.7*	-	-	R^2= 0.037*	P= 0.034	493.1	249.6	23693.7
5.	Linearized Power	-	149.2 NS	-	-	R^2= 0.005 NS	P= 0.405	542.1	153.3	37520.0
6.	Linearized Exponential	2.88 x10^{-65} NS	0.07 NS	-	-	R^2= 0.005 NS	P= 0.405	542.1	153.3	37520.0
7.	Linearized Growth	-148.60NS	0.07 NS	-	-	R^2= 0.005 NS	P= 0.405	542.1	153.3	37520.0
8.	Linearized S-curve	149.9NS	-300 445.4 NS	-	-	R^2= 0.005 NS	P= 0.405	542.1	153.3	37520.0
9.	Exponential Smoothing	0.84	-	-	-	χ^2= 0.002	P< 0.000	408.5	151.5	19020.1
10.	ARIMA (2,0,2) (1,0,0) [12]	-	-	-	-	χ^2= 0.09	P< 0.000 AIC= 1761.9	350.1	184.9	18111.1

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.67, although many linearized models have significant R^2 values, the ARIMA(2,0,2)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1761.9), as indicated above, among various models fitted apart from lowest error measures like RMSE (350.1), MAE (184.9) and MAPE (18111.1). Thus, ARIMA model is chosen as best model for forecasting of sesame arrivals in Jashpurnagar market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of sesame in Jashpurnagar market were obtained as presented in the Table 4.68.

Table 4.68: Parameters of Fitted Model of Prices of Sesame in Jashpurnagar Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-330202**	164.37**	-	-	R^2= 0.074**	P= 0.002	1680.8	1353.3	135351.5
	2nd order	12275 6640NS	-122 036.8 NS	30.3 NS	-	R^2= 0.090**	P= 0.003	1673.2	1329.0	132924.7
	3rd order	773.7$	-524.4 NS	152.1 NS	-9.0 NS	R^2= 0.098**	P= 0.006	1672.6	1322.2	132239.1
2.	Linearized Compound	2.87x 10^{-155} NS	1.1 NS	-	-	R^2= 0.017 NS	P= 0.145	1976.1	940.0	733421.0
3.	Linearized Inverse	331 850.9**	-666 654717**	-	-	R^2= 0.074**	P= 0.002	1680.9	1353.4	135360.7
4.	Linearized Logarithmic	-251 7569**	331 026.5**	-	-	R^2= 0.074**	P= 0.002	1680.9	1353.4	135356.1
5.	Linearized Power	-	357 NS	-	-	R^2= 0.017 NS	P= 0.145	1976.1	940.0	732345.9
6.	Linearized Exponential	2.87x 10^{-155} NS	0.17 NS	-	-	R^2= 0.017 NS	P= 0.145	1976.1	940.0	733345.0
7.	Linearized Growth	-355.8 NS	0.17 NS	-	-	R^2= 0.017 NS	P= 0.145	1976.1	940.0	733345.0
8.	Linearized S-curve	358.3 NS	-718 902.9 NS	-	-	R^2= 0.017 NS	P= 0.145	1976.1	940.0	732345.8
9.	Exponential Smoothing	0.46	-	-	-	χ^2= 0.008	P< 0.000	1672.9	1057.1	99077.0
10.	ARIMA (3,1,2) (0,0,1) [12]	-	-	-	-	χ^2= 0.05	P< 0.000 AIC= 2096.2	1504.7	1029.0	90936.2

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.68, although many linearized models have significant R^2 values, the ARIMA(3,1,2)(0,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2096.2), as indicated above, among various models fitted apart from lowest error measures like RMSE (1504.7), MAE (1029.0) and MAPE (90936.2). Thus, ARIMA model is chosen as best model for forecasting of sesame prices in Jashpurnagar market.

4.17.2.4 Forecasting of Arrivals and Prices of Sesame in Jashpurnagar Market

After identification of the model, forecasting of arrivals and prices of sesame has been done. The best ARIMA model has been used to forecast the arrivals and prices of sesame in Jashpurnagar market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.69 and also depitcted in graph in Fig 4.46.

Table 4.69: Forecasted values of Arrivals and Prices of Sesame in Jashpurnagar Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	158.93	148.46	4515.43	2200.58
February	163.43	147.81	3853.74	2268.52
March	166.18	147.40	2914.60	2285.32
April	167.09	147.26	2247.14	2266.73
May	170.25	146.79	1719.72	2224.16
June	172.28	146.49	1399.95	2171.75
July	172.74	146.42	1261.16	2119.82
August	172.42	146.47	1278.56	2076.20
September	172.03	146.53	1397.29	2044.92
October	171.84	146.55	1577.22	2027.12
November	155.59	148.95	1905.61	2021.52
December	151.07	149.62	2084.86	2025.44

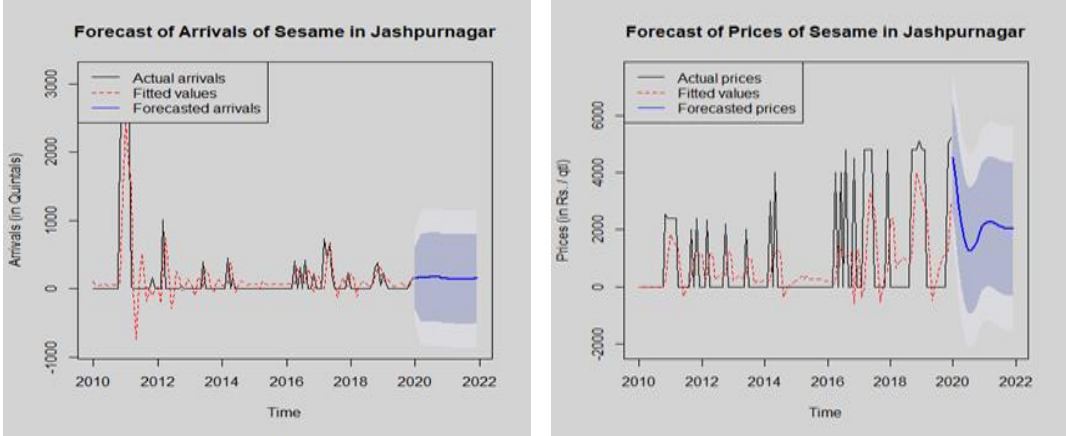


Fig. 4.46: Forecasts of arrivals and prices of sesame in Jashpurnagar

From the Table 4.69, the highest forecasted arrivals of sesame for Jashpurnagar are expected to be 172.74 quintals and 149.62 quintals respectively in the month of July, 2020 and December, 2021 with respective forcasted prices to be Rs. 1261.16/quintal and Rs. 2025.44/quintal. However, the maximum prices were found to be Rs. 4515.43/quintal in the month of January, 2020 and Rs. 2285.32/quintal in the month of March, 2021.

4.17.3 Mustard

4.17.3.1 Trend in Arrivals and Prices of Mustard in Jashpurnagar Market

Time series data for arrivals of mustard in Jashpurnagar has been presented in Fig. 4.47: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 200 quintals in September 2015 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of mustard have also been plotted over the observed time series.

The linearized trend in the arrivals of mustard in Jashpurnagar has been indicated by dark-green line in the graph shown in Fig. 4.47: (e). It could be seen that the arrivals of mustard in Jashpurnagar had shown a decreasing trend over the years.

Similarly time series data for prices of mustard in Jashpurnagar has been presented in Fig. 4.47: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 6150 in September 2018 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of mustard have also been plottted.

The linearized trend in the prices of mustard in Jashpurnagar has been indicated by dark-green line in the graph shown in Fig. 4.47: (f). It could be seen that the prices of mustard in Jashpurnagar had shown an increasing trend over the years.

4.17.3.2 Seasonality pattern in Arrivals and Prices of Mustard in Jashpurnagar Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.47: (g). The seasonal variation has been plotted in the graph of mustard arrivals in Jashpurnagar as shown there.

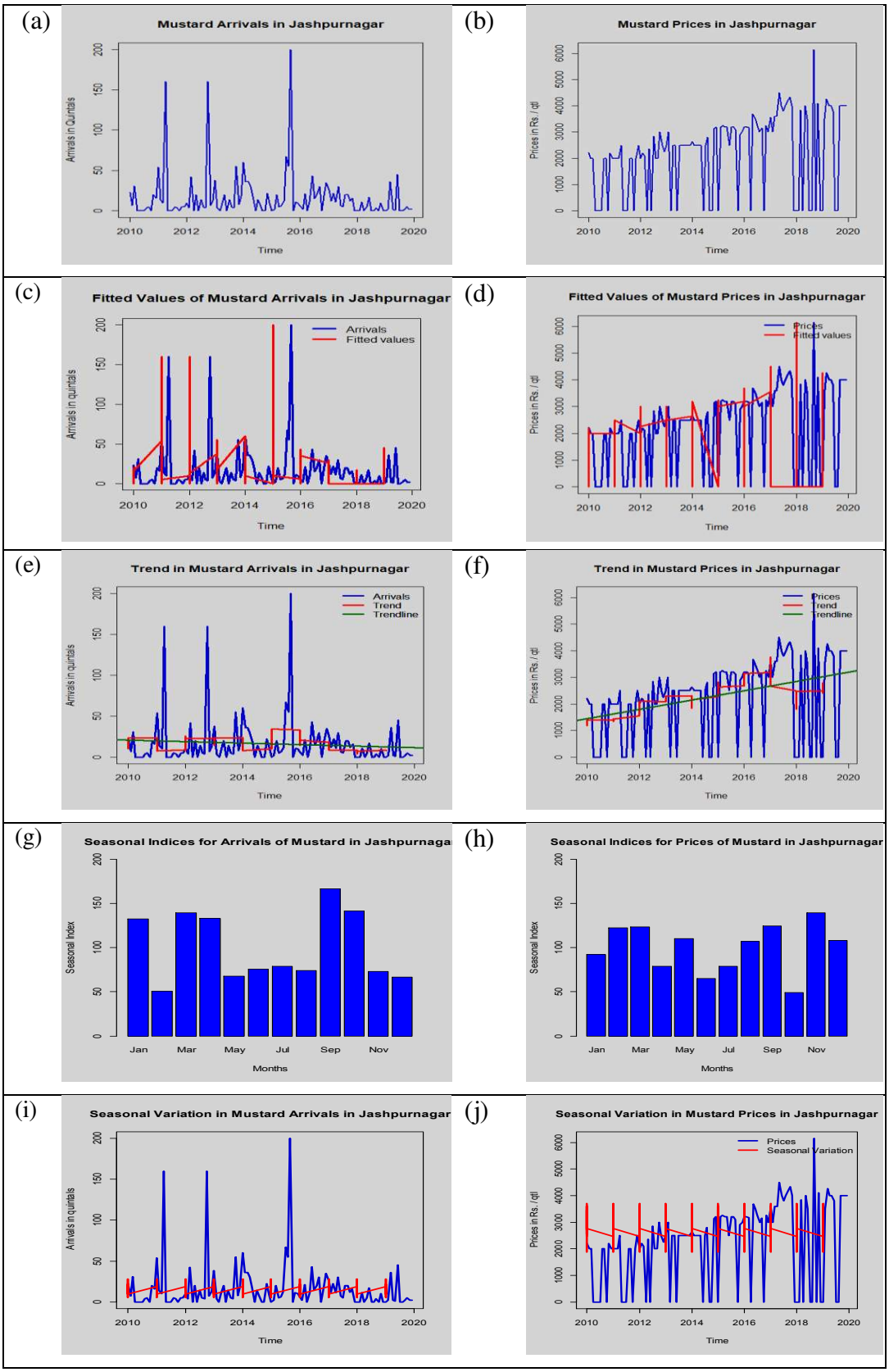


Fig. 4.47: Trend and Seasonality pattern in Arrivals and Prices of mustard in Jashpurnagar

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.47: (h). The seasonal variation has been plotted in the graph of mustard prices in Jashpurnagar.

4.17.3.3 Identifying the Best Forecasting Model for Arrivals and Prices of Mustard in Jashpurnagar Market

By fitting different linear and non-linear time series models, we got following results for arrivals of mustard in Jashpurnagar market were obtained as presented in the Table 4.70.

Table 4.70: Parameters of Fitted Model of Arrivals of Mustard in Jashpurnagar

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	1856.9^{NS}	-0.91 ^{NS}	-	-	R^2= 0.008 ^{NS}	P= 0.329	29.3	16.3	960.4
	2nd order	-288 8075$^{\$}$	2868.2$^{\$}$	-0.7$^{\$}$	-	R^2= 0.039$^{\$}$	P= 0.095	29.0	15.6	858.0
	3rd order	10.5 ^{NS}	7.9 ^{NS}	-1.4 ^{NS}	0.05 ^{NS}	R^2= 0.020 ^{NS}	P= 0.186	29.1	15.7	858.1
2.	Linearized Compound	2.32x 10^{37} ^{NS}	0.9 ^{NS}	-	-	R^2= 0.005 ^{NS}	P= 0.436	31.4	14.7	3305.0
3.	Linearized Inverse	-1819.5 ^{NS}	369 8526 ^{NS}	-	-	R^2= 0.008 ^{NS}	P= 0.330	29.3	16.3	9605.0
4.	Linearized Logarithmic	14001.9 ^{NS}	-1838.2 ^{NS}	-	-	R^2= 0.008 ^{NS}	P= 0.330	29.3	16.3	9604.0
5.	Linearized Power	-	-84.13 ^{NS}	-	-	R^2= 0.008 ^{NS}	P= 0.330	31.4	14.7	3305.0
6.	Linearized Exponential	2.32x 10^{37} ^{NS}	-0.04 ^{NS}	-	-	R^2= 0.005 ^{NS}	P= 0.436	31.4	14.7	3305.0
7.	Linearized Growth	86 ^{NS}	-0.04 ^{NS}	-	-	R^2= 0.005 ^{NS}	P= 0.436	31.4	14.7	3305.0
8.	Linearized S-curve	-82.23^{NS}	169 053.9 ^{NS}	-	-	R^2= 0.005 ^{NS}	P= 0.436	31.4	14.7	3305.0
9.	Exponential Smoothing	0.02	-	-	-	χ^2= 0.134	P< 0.000	29.6	17.8	1177.7
10.	ARIMA (0,0,0) (1,0,1) [12]	-	-	-	-	χ^2= 0.207	P< 0.000 AIC= 1158.1	29.1	16.0	961.5

Note:- Polynomial model of 2nd order is significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.70, although many linearized models have significant R^2 values, the ARIMA(0,0,0)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1158.1), as indicated above, among various models fitted apart from lowest error measures like RMSE (16.0), MAE (16.0) and MAPE (961.5). Thus, ARIMA model is chosen as best model for forecasting of mustard arrivals in Jashpurnagar market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of mustard in Jashpurnagar market were obtained as presented in the Table 4.71.

Table 4.71: Parameters of Fitted Model of Prices of Mustard in Jashpurnagar Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-350137***	174.9***	-	-	R^2= 0.115***	P< 0.000	1403.8	1146.6	114685.9
	2nd order	-106201470NS	105264.6 NS	-26.0 NS	-	R^2= 0.131***	P< 0.000	1396.7	1116.6	111642.4
	3rd order	1186.5**	301.9 NS	5.4 NS	-2.3 NS	R^2= 0.132***	P< 0.000	1402.1	1118.7	111827.0
2.	Linearized Compound	$1.12x10^{-59}$ NS	1.07 NS	-	-	R^2= 0.002 NS	P= 0.564	2426.1	2110.6	16425.8
3.	Linearized Inverse	3547 58.5***	-7101 71493***	-	-	R^2= 0.115***	P< 0.000	1403.8	1146.5	114675.5
4.	Linearized Logarithmic	-267 9239***	35 2447.7***	-	-	R^2= 0.115***	P< 0.000	1403.8	1146.5	114680.7
5.	Linearized Power	-	141.77 NS	-	-	R^2= 0.002 NS	P= 0.564	2426.1	2110.6	16426.9
6.	Linearized Exponential	$1.12x10^{-59}$ NS	0.07 NS	-	-	R^2= 0.002 NS	P= 0.564	2426.1	2110.6	16425.8
7.	Linearized Growth	-135.7 NS	0.07 NS	-	-	R^2= 0.002 NS	P= 0.564	2426.1	2110.6	16425.8
8.	Linearized S-curve	147.8 NS	-286 221.6 NS	-	-	R^2= 0.002 NS	P= 0.564	2426.1	2110.6	16427.9
9.	Exponential Smoothing	0.07	-	-	-	χ^2= 0.56	P< 0.000	1450.9	1228.3	115508.2
10.	ARIMA (0,1,1) (1,0,0) [12]	-	-	-	-	χ^2= 0.43	P< 0.000 AIC= 2068.1	1379.8	1132.5	99654.7

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.71, although many linearized models have significant R^2 values, the ARIMA(0,1,1)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2068.1), as indicated above, among various models fitted apart from lowest error measures like RMSE (1379.82), MAE (1132.57) and MAPE (99654.7). Thus, ARIMA model is chosen as best model for forecasting of mustard prices in Jashpurnagar market.

4.17.3.4 Forecasting of Arrivals and Prices of Mustard in Jashpurnagar Market

After identification of the model, forecasting of arrivals and prices of mustard has been done. The best ARIMA model has been used to forecast the arrivals and prices of mustard in Jashpurnagar market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.72 and also depitcted in graph in Fig 4.48.

Table 4.72: Forecasted values of Arrivals and Prices of Mustard in Jashpurnagar Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	16.39	16.36	2109.38	2682.35
February	15.95	16.71	3060.09	2940.60
March	16.55	16.24	3266.91	2996.77
April	17.67	15.36	3195.90	2977.49
May	16.39	16.36	3195.90	2977.49
June	16.79	16.05	3141.58	2962.73
July	16.99	15.89	2109.38	2682.35
August	17.17	15.75	2109.38	2682.35
September	20.00	13.53	3195.90	2977.49
October	15.55	17.02	3195.90	2977.49
November	15.54	17.03	3195.90	2977.49
December	15.30	17.22	3195.90	2977.49

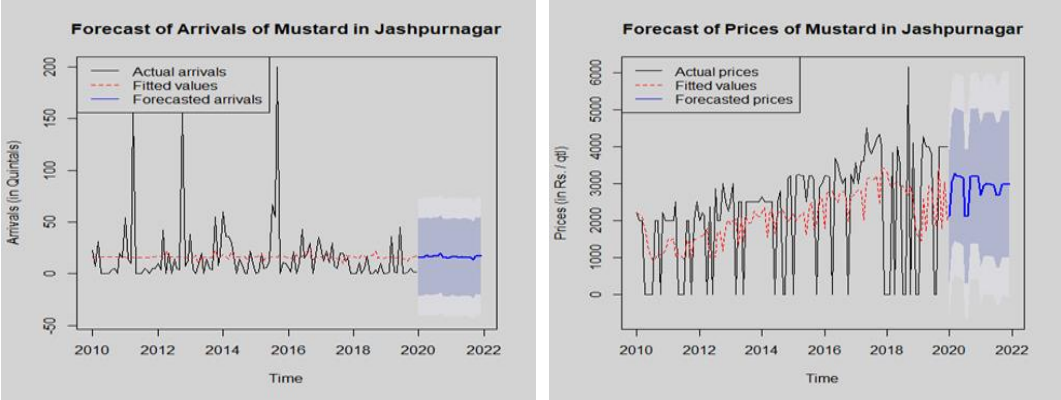


Fig. 4.48: Forecasts of Arrivals and Prices of Mustard in Jashpurnagar Market

From the Table 4.17.3.3, the highest forecasted arrivals of mustard for Jashpurnagar are expected to be 20.00 quintals and 17.03 quintals respectively in the month of September, 2020 and November, 2021 with respective forcasted prices to be Rs. 3195.90/quintal and Rs. 2977.49/quintal. However, the maximum prices were found to be Rs. 3266.91/quintal in the month of March, 2020 and Rs. 2996.77/quintal in the month of March, 2021.

4.18 Results for Arrivals and Prices of Oilseeds in Ramanujganj Market

4.18.1 Groundnut

4.18.1.1 Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Ramanujganj Market

Time series data for arrivals of groundnut in Ramanujganj has been presented in Fig. 4.49: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 102 quintals in March 2014 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut have also been plotted over the observed time series.

The linearized trend in the arrivals of groundnut in Ramanujganj has been indicated by dark-green line in the graph shown in Fig. 4.49: (e). It could be seen that the arrivals of groundnut in Ramanujganj had shown an increasing trend over the years.

Similarly time series data for prices of groundnut in Ramanujganj has been presented in Fig. 4.49: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4900 in most of the monts of 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Ramanujganj has been indicated by dark-green line in the graph shown in Fig. 4.49: (f). It could be seen that the prices of groundnut in Ramanujganj had shown an increasing trend over the years.

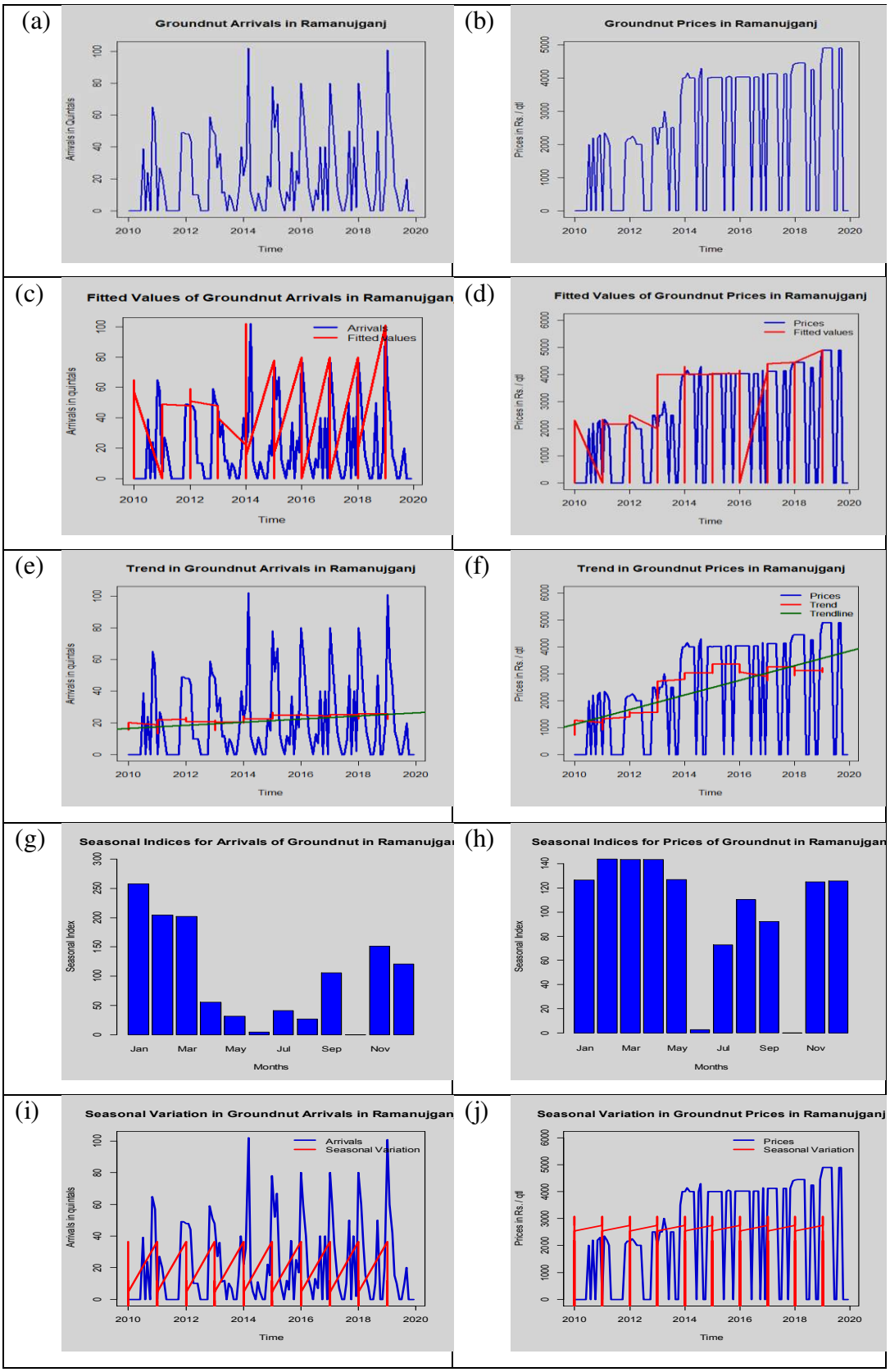


Fig. 4.49: Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Ramanujganj

4.18.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Ramanujganj Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.49: (g). The seasonal variation has been plotted in the graph of groundnut arrivals in Ramanujganj.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.49: (h). The seasonal variation has been plotted in the graph of groundnut prices in Ramanujganj.

4.18.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Ramanujganj Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Ramanujganj market were obtained as presented in the Table 4.73.

Table 4.73: Parameters of Fitted Model of Arrivals of Groundnut in Ramanujganj

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-1998.7 ^{NS}	1 ^{NS}	-	-	R^2= 0.013 ^{NS}	P= 0.206	24.8	20.4	1475.0
	2nd order	-939 689.4 ^{NS}	931.9 ^{NS}	-0.2 ^{NS}	-0.05 ^{NS}	R^2= 0.018 ^{NS}	P= 0.343	24.8	20.3	1434.7
	3rd order	14.9*	0.6 ^{NS}	0.4 ^{NS}	-	R^2= 0.019 ^{NS}	P= 0.513	24.9	20.2	1436.8
2.	Linearized Compound	1.85 x10^{-84} ^{NS}	1.1 ^{NS}	-	-	R^2= 0.020 ^{NS}	P= 0.122	28.8	19.2	460.4
3.	Linearized Inverse	2041.9 ^{NS}	-407 1414 ^{NS}	-	-	R^2= 0.013 ^{NS}	P= 0.206	24.8	20.4	1474.9
4.	Linearized Logarithmic	-15350 ^{NS}	2020.3 ^{NS}	-	-	R^2= 0.013 ^{NS}	P= 0.206	24.8	20.4	1474.9
5.	Linearized Power	-	194.7^{NS}	-	-	R^2= 0.020 ^{NS}	P= 0.122	28.8	19.2	460.4
6.	Linearized Exponential	1.85 x10^{-84} ^{NS}	0.09 ^{NS}	-	-	R^2= 0.020 ^{NS}	P= 0.122	28.8	19.2	460.4
7.	Linearized Growth	-192.8 ^{NS}	0.09 ^{NS}	-	-	R^2= 0.020 ^{NS}	P= 0.122	28.8	19.2	460.4
8.	Linearized S-curve	196.7 ^{NS}	-392 701 ^{NS}	-	-	R^2= 0.020 ^{NS}	P= 0.122	28.8	19.2	460.3
9.	Exponential Smoothing	0.06	-	-	-	χ^2= 13.33	P< 0.000	25.6	20.2	1175.9

10.	ARIMA (1,0,0) (1,1,0) [12]	-	-	-	-	χ^2= 0.0001	P< 0.000 AIC =907.9	14.9	8..0	337.7

Note:- None of the Polynomial models are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.73, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(1,1,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=907.9), as indicated above, among various models fitted apart from lowest error measures like RMSE (14.9), MAE (8.0) and MAPE (337.7). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Ramanujganj market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Ramanujganj market were obtained as presented in the Table 4.74.

Table 4.74: Parameters of Fitted Model of Prices of Groundnut in Ramanujganj

S. N.	**Models**	**α**	**β_1**	**β_2**	**β_3**	**R^2 / Test-Statistics**	**P-value / AIC**	**RMSE**	**MAE**	**MAPE**
1.	Linearized Polynomial 1st order	-1998.7***	1***	-	-	R^2= 0.171***	P< 0.000	1729.0	1522.6	152283.5
	2nd order	-939689**	931.9**	-0.23**	-	R^2= 0.228***	P< 0.000	1675.7	1414.5	140949.4
	3rd order	530.7NS	561.6 NS	16.2 NS	-5.7 NS	R^2= 0.231***	P< 0.000	1679.8	1414.8	141163.5
2.	Linearized Compound	2.43x 10^{-256*}	1.34*	-	-	R^2= 0.040*	P= 0.028	2837.3	2311.1	142868.0
3.	Linearized Inverse	5502242***	-11037 26358***	-	-	R^2= 0.171***	P< 0.000	1728.7	1522.2	152249.9
4.	Linearized Logarithmic	-4164584***	547 695.2***	-	-	R^2= 0.171***	P< 0.000	1728.7	1522.2	152266.7
5.	Linearized Power	-	594.1*	-	-	R^2= 0.040*	P= 0.028	2837.3	2311.1	142906.0
6.	Linearized Exponential	2.43 x10^{-256*}	0.29*	-	-	R^2= 0.040*	P= 0.028	2837.3	2311.1	142868.0
7.	Linearized Growth	-588.5*	0.29*	-	-	R^2= 0.040*	P= 0.028	2837.3	2311.1	142868.0
8.	Linearized S-curve	599.6*	-1197 860*	-	-	R^2= 0.040*	P= 0.028	2837.3	2311.1	142943.0
9.	Exponential Smoothing	0.10	-	-	-	χ^2= 3.58	P< 0.000	1752.5	1518.8	133819.0

10.	ARIMA (1,0,0) (1,1,0) [12]	-	-	-	-	χ^2= 0.20	P< 0.000 AIC= 1234.1	1208.8	658.5	47460.7

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.74, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(1,1,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1234.1), as indicated above, among various models fitted apart from lowest error measures like RMSE (1208.8), MAE (658.5) and MAPE (47460.7). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Ramanujganj market.

4.18.1.4 Forecasting of Arrivals and Prices of Groundnut in Ramanujganj Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Ramanujganj market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.74 and also depitcted in graph in Fig 4.50.

Table 4.75: Forecasted values of Arrivals and Prices of Groundnut in Ramanujganj

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	96.89	97.50	3936.84	4032.45
February	59.94	59.94	4665.95	4689.18
March	40.96	41.12	4816.24	4824.55
April	14.99	14.99	4847.26	4852.49
May	9.70	9.74	4853.66	4858.26
June	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00
August	10.00	10.00	4835.46	4841.86
September	24.40	23.75	4835.47	4841.87
October	0.00	0.00	0.00	0.00
November	0.00	0.00	0.00	0.00
December	2.93	2.50	441.74	397.89

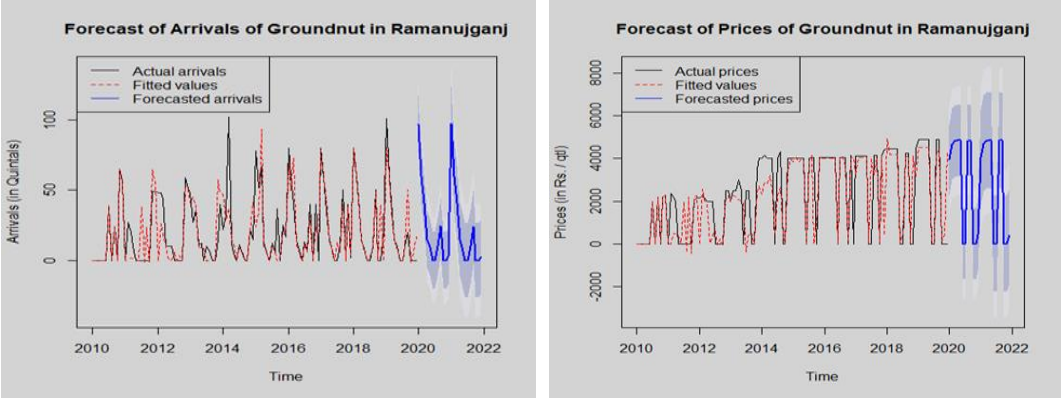


Fig. 4.50: Forecasts of Arrivals and Prices of Groundnut in Ramanujganj

From the Table 4.75, the highest forecasted arrivals of groundnut for Ramanujganj are expected to be 96.89 quintals and 97.50 quintals respectively in the month of January, 2020 and January, 2021 with respective forcasted prices to be Rs. 3936.84/quintal and Rs. 4032.45/quintal. However, the maximum prices were found to be Rs. 4858.26/quintal in the month of May, 2020 and Rs. 4858.26/quintal in the month of May, 2021.

4.18.2 Sesame

4.18.2.1 Trend in Arrivals and Prices of Sesame in Ramanujganj Market

Time series data for arrivals of sesame in Ramanujganj has been presented in Fig. 4.51: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 1460 quintals in November 2013 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of sesame have also been plotted over the observed time series.

The linearized trend in the arrivals of sesame in Ramanujganj has been indicated by dark-green line in the graph shown in Fig. 4.51: (e). It could be seen that the arrivals of sesame in Ramanujganj had shown a decreasing trend over the years.

Similarly time series data for prices of sesame in Ramanujganj has been presented in Fig. 4.51: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 7000 in January 2018 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of sesame have also been plottted.

The linearized trend in the prices of sesame in Ramanujganj has been indicated by dark-green line in the graph shown in Fig. 4.51: (f). It could be seen that the prices of sesame in Ramanujganj had shown a decreasing trend over the years.

4.18.2.2 Seasonality pattern in Arrivals and Prices of Sesame in Ramanujganj Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.51: (g). The seasonal variation has been plotted in the graph of sesame arrivals in Ramanujganj.

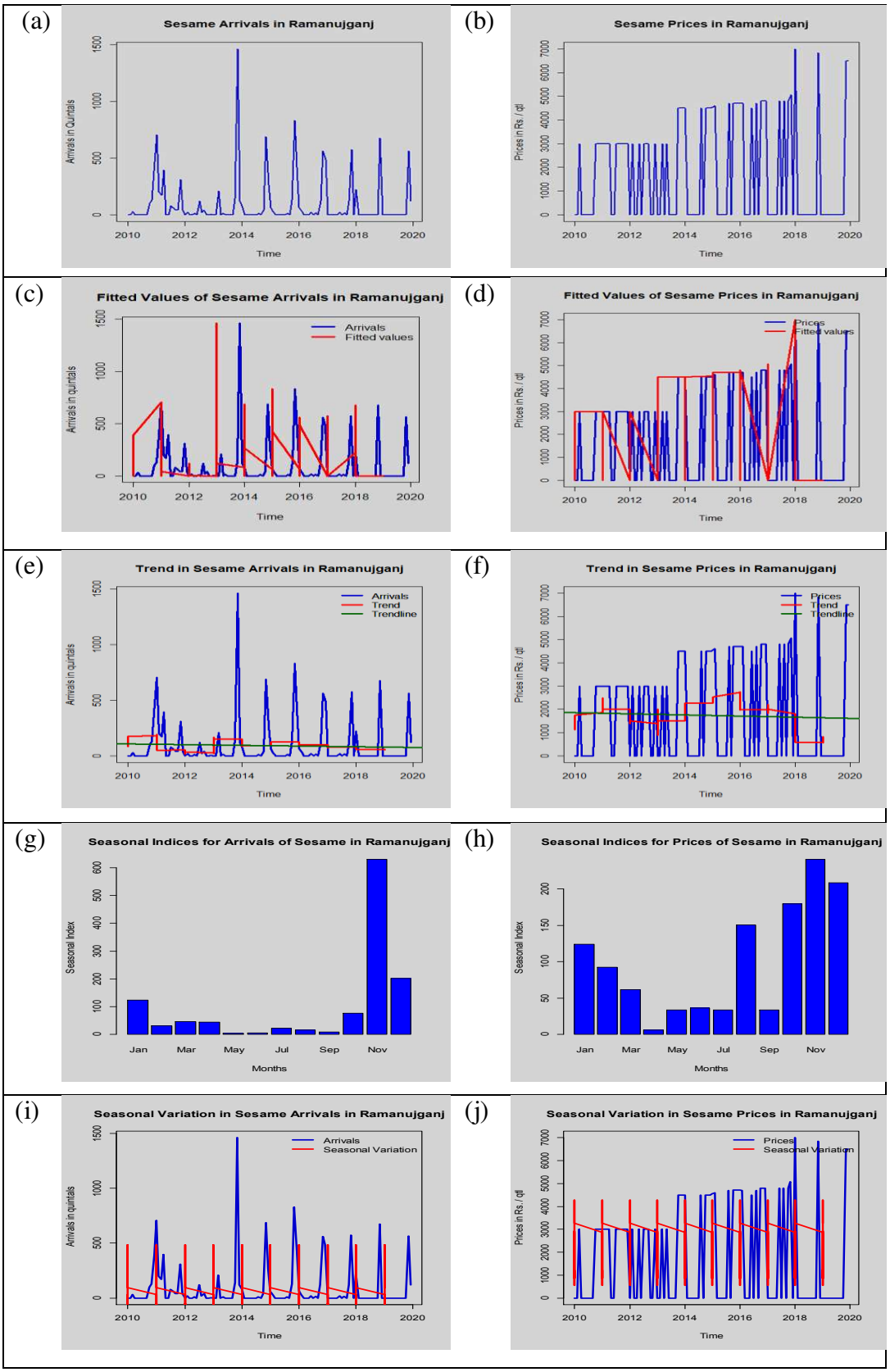


Fig. 4.51 : Trend and Seasonality pattern in Arrivals and Prices of Sesame in Ramanujganj

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.51: (h). The seasonal variation has been plotted in the graph of sesame prices in Ramanujganj.

4.18.2.3 Identifying the Best Forecasting Model for Arrivals and Prices of Sesame in Ramanujganj Market

By fitting different linear and non-linear time series models, we got following results for arrivals of sesame in Ramanujganj market were obtained as presented in the Table 4.76.

Table 4.76: Parameters of Fitted Model of Arrivals of Sesame in Ramanujganj

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	6823^{NS}	-3.3^{NS}	-	-	R^2= 0.002^{NS}	P= 0.624	213.9	128.3	10493.8
	2nd order	-904 9834^{NS}	8988.1^{NS}	-2.2^{NS}	-	R^2= 0.007^{NS}	P= 0.629	214.2	128.2	10280.6
	3rd order	74^{NS}	27.6^{NS}	-5.4^{NS}	0.2^{NS}	R^2= 0.008^{NS}	P= 0.809	215.1	128.3	10279.3
2.	Linearized Compound	1.70 x 10^{157*}	0.8*	-	-	R^2= 0.035*	P= 0.040	524.1	153.3	58760.0
3.	Linearized Inverse	-66 25.1^{NS}	135 31309^{NS}	-	-	R^2= 0.002^{NS}	P= 0.624	493.1	249.6	10494.4
4.	Linearized Logarithmic	51 249.7^{NS}	-6724.1^{NS}	-	-	R^2= 0.002^{NS}	P= 0.624	493.1	249.6	10494.1
5.	Linearized Power	-	-360.4*	-	-	R^2= 0.035*	P= 0.040	524.1	153.3	58760.0
6.	Linearized Exponential	1.70 x 10^{157*}	-0.17*	-	-	R^2= 0.035*	P= 0.040	524.1	153.3	58760.0
7.	Linearized Growth	362*	-0.17*	-	-	R^2= 0.035*	P= 0.040	524.1	153.3	58760.0
8.	Linearized S-curve	-358.7*	72 5781.1*	-	-	R^2= 0.035*	P= 0.040	524.1	153.3	58760.0
9.	Exponential Smoothing	0.03	-	-	-	χ^2= 6.25	P< 0.000	408.5	151.5	8437.2
10.	ARIMA (1,0,0) (2,0,0) [12]	-	-	-	-	χ^2= 0.008	P< 0.000 AIC= 1581.6	164.2	83.9	7136.1

Note:- None of the Polynomial models are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.76, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(2,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1581.6), as indicated above, among various models fitted apart from lowest error measures like RMSE (164.2), MAE (83.9) and MAPE (7136.1). Thus, ARIMA model is chosen as best model for forecasting of sesame arrivals in Ramanujganj market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of sesame in Ramanujganj market were obtained as presented in the Table 4.77.

Table 4.77: Parameters of Fitted Model of Prices of Sesame in Ramanujganj

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	53352.1^{NS}	-25.6^{NS}	-	-	R^2= 0.001^{NS}	P= 0.711	2170.0	1989.3	198962.1
	2nd order	-203909306$^{\$}$	202469.4$^{\$}$	-50.2$^{\$}$	-	R^2= 0.029^{NS}	P= 0.169	2147.7	1939.1	193935.9
	3rd order	1365.6*	226.8$^{\$}$	8.2$^{\$}$	-4.3$^{\$}$	R^2= 0.031^{NS}	P= 0.296	2155.5	1940.1	194040.0
2.	Linearized Compound	7.78x 10^{278*}	0.72*	-	-	R^2= 0.042*	P= 0.024	2774.0	1774.3	343570.0
3.	Linearized Inverse	-49542^{NS}	1033915917^{NS}	-	-	R^2= 0.001^{NS}	P= 0.712	2170.1	1989.5	198973.6
4.	Linearized Logarithmic	393160.1^{NS}	-51447^{NS}	-	-	R^2= 0.001^{NS}	P= 0.712	2170.1	1989.5	198967.9
5.	Linearized Power	-	-638.7*	-	-	R^2= 0.042*	P= 0.024	2774.0	1774.3	343540.0
6.	Linearized Exponential	7.78x 10^{278*}	-0.31*	-	-	R^2= 0.042*	P= 0.024	2774.0	1774.3	343570.0
7.	Linearized Growth	642.1*	-0.31*	-	-	R^2= 0.042*	P= 0.024	2774.0	1774.3	343570.0
8.	Linearized S-curve	-635.3*	1286207*	-	-	R^2= 0.042*	P= 0.024	2774.0	1774.3	343510.0
9.	Exponential Smoothing	0.08	-	-	-	χ^2= 3.05	P< 0.000	2221.8	1991.7	184193.0
10.	ARIMA (1,1,1) (1,0,1) [12]	-	-	-	-	χ^2= 0.001	P< 0.000 AIC= 2165	1917.6	1628.6	156415.8

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.77, although many linearized models have significant R^2 values, the ARIMA(1,1,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2165), as indicated above, among various models fitted apart from lowest error measures like RMSE (1917.6), MAE (1628.6) and MAPE (156415.8). Thus, ARIMA model is chosen as best model for forecasting of sesame prices in Ramanujganj market.

4.18.2.3 Forecasting of Arrivals and Prices of Sesame in Ramanujganj Market

After identification of the model, forecasting of arrivals and prices of sesame has been done. The best ARIMA model has been used to forecast the arrivals and prices of sesame in Ramanujganj market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.78 and also depitcted in graph in Fig 4.52.

Table 4.78: Forecasted values of Arrivals and Prices of Sesame in Ramanujganj Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	132.86	65.70	2468.44	1948.77
February	32.21	37.85	979.32	1148.11
March	29.55	37.11	798.90	1055.21
April	29.05	36.97	784.37	1049.58
May	28.96	36.95	784.87	1050.54
June	28.94	36.94	1046.47	1231.08
July	28.93	36.94	782.98	1049.33
August	28.93	36.94	1081.87	1255.51
September	28.93	36.94	782.97	1049.33
October	28.93	36.94	1085.58	1258.07
November	447.53	372.29	4127.09	3356.11
December	62.41	93.39	3103.03	2649.71

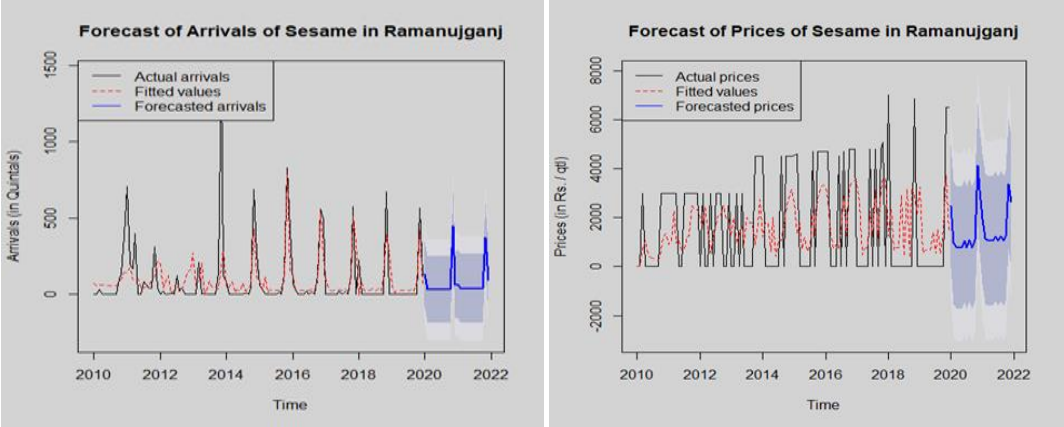


Fig. 4.52: Forecasts of Arrivals and Prices of Sesame in Ramanujganj

From the Table 4.78, the highest forecasted arrivals of sesame for Ramanujganj are expected to be 447.53 quintals and 372.29 quintals respectively in the month of November, 2020 and January, 2021 with respective forcasted prices to be Rs. 4127.09/quintal and Rs. 3356.11/quintal. However, the maximum prices were found to be Rs. 4127.09/quintal in the month of January, 2020 and Rs. 3356.11/quintal in the month of January, 2021.

4.18.3 Linseed

4.18.3.1 Trend in Arrivals and Prices of Linseed in Ramanujganj Market

Time series data for arrivals of linseed in Ramanujganj has been presented in Fig. 4.53: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 418 quintals in April 2013 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of linseed have also been plotted over the observed time series.

The linearized trend in the arrivals of linseed in Ramanujganj has been indicated by dark-green line in the graph shown in Fig. 4.53: (e). It could be seen that the arrivals of linseed in Ramanujganj had shown a decreasing trend over the years.

Similarly time series data for prices of linseed in Ramanujganj has been presented in Fig. 4.53: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 4000 in most of the months of 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of linseed have also been plottted.

The linearized trend in the prices of linseed in Ramanujganj has been indicated by dark-green line in the graph shown in Fig. 4.53: (f). It could be seen that the prices of linseed in Ramanujganj had shown an increasing trend over the years.

4.18.3.2 Seasonality pattern in Arrivals and Prices of Linseed in Ramanujganj Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown there. The seasonal variation has been plotted in the graph of linseed arrivals in Ramanujganj.

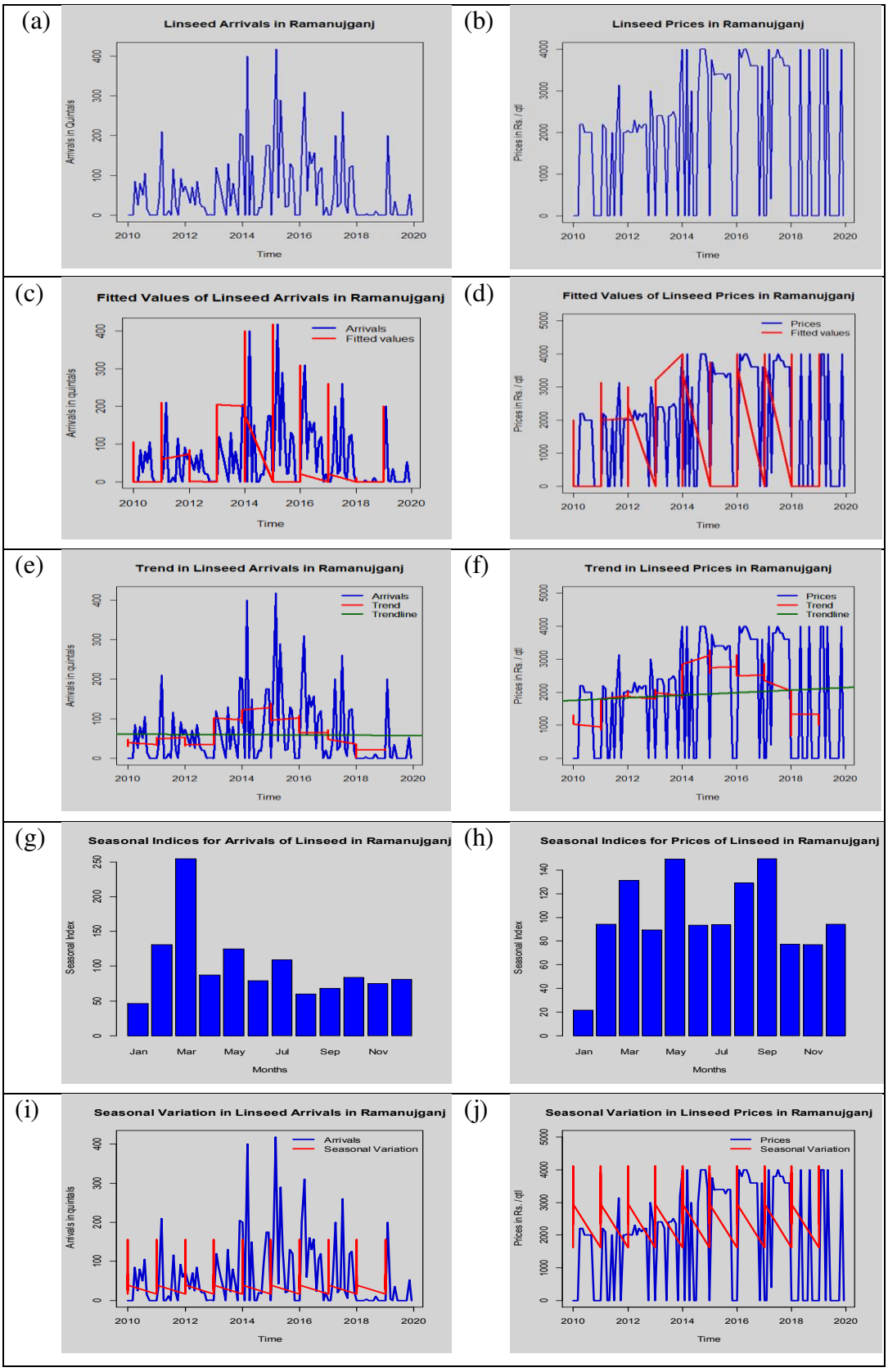


Fig. 4.53: Trend and Seasonality pattern in Arrivals and Prices of Linseed in Ramanujganj Market

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown there. The seasonal variation has been plotted in the graph of linseed prices in Ramanujganj.

4.18.3.3 Identifying the Best Forecasting Model for Arrivals and Prices of Linseed in Ramanujganj Market

By fitting different linear and non-linear time series models, we got following results for arrivals of linseed in Ramanujganj market were obtained as presented in the Table 4.79.

Table 4.79: Parameters of Fitted Model of Arrivals of Linseed in Ramanujganj Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	559.73^{NS}	-0.24^{NS}	-	-	R^2= 0.000^{NS}	P= 0.926	84.6	63.6	4520.4
	2nd order	-1625 1463***	16 134.8***	-4***	-	R^2= 0.120***	P< 0.000	79.7	57.7	3615.3
	3rd order	23.7^{NS}	14.6^{NS}	2.1^{NS}	-0.4^{NS}	R^2= 0.129***	P= 0.001	79.6	57.3	3632.4
2.	Linearized Compound	1.30x $10^{106\,NS}$	0.8^{NS}	-	-	R^2= 0.019^{NS}	P= 0.126	98.2	57.6	3632.4
3.	Linearized Inverse	-415.7^{NS}	956 783.7^{NS}	-	-	R^2= 0.000^{NS}	P= 0.930	84.6	63.6	4520.9
4.	Linearized Logarithmic	3770.1^{NS}	-487.75^{NS}	-	-	R^2= 0.000^{NS}	P= 0.930	84.6	63.6	4520.6
5.	Linearized Power	-	-241.6^{NS}	-	-	R^2= 0.019^{NS}	P= 0.126	98.2	57.6	4370.0
6.	Linearized Exponential	1.30x $10^{106\,NS}$	-0.12^{NS}	-	-	R^2= 0.019^{NS}	P= 0.126	98.2	57.6	4370.0
7.	Linearized Growth	244.3^{NS}	-0.12^{NS}	-	-	R^2= 0.019^{NS}	P= 0.126	98.2	57.6	4370.0
8.	Linearized S-curve	-239^{NS}	48 6045.6^{NS}	-	-	R^2= 0.019^{NS}	P= 0.126	98.2	57.6	4370.0
9.	Exponential Smoothing	0.10	-	-	-	χ^2= 0.07	P< 0.000	82.4	60.1	4215.0
10.	ARIMA (0,0,0) (0,0,1) [12]	-	-	-	-	χ^2= 0.47	P< 0.000 AIC= 1392.2	77.2	58.2	3138.4

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.79, although many linearized models have significant R^2 values, the ARIMA(0,0,0)(0,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1392.2), as indicated above, among various models fitted apart from lowest error measures like RMSE (77.2), MAE (58.2) and MAPE (3138.4). Thus, ARIMA model is chosen as best model for forecasting of linseed arrivals in Ramanujganj market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of linseed in Ramanujganj market were obtained as presented in the Table 4.80.

Table 4.80: Parameters of Fitted Model of Prices of Linseed in Ramanujganj Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-771 118.9^{NS}	38.2^{NS}	-	-	R^2= 0.004^{NS}	P= 0.446	1616.2	1455.1	142838.0
	2nd order	-3359 18109^{***}	333 463.6^{***}	-82.7^{***}	-	R^2= 0.145^{***}	P< 0.000	1504.5	1273.2	124078.4
	3rd order	993.1^{*}	346.1^{NS}	45.4^{NS}	-9.4^{NS}	R^2= 0.155^{***}	P< 0.000	1501.4	1271.5	123870.1
2.	Linearized Compound	4.57x $10^{174\,NS}$	0.82^{NS}	-	-	R^2= 0.018^{NS}	P= 0.140	2429.1	1911.5	178422.0
3.	Linearized Inverse	81 494.9^{NS}	-1602 96599^{NS}	-	-	R^2= 0.004^{NS}	P= 0.443	1616.1	1455.2	142845.4
4.	Linearized Logarithmic	-601 454.1^{NS}	79306.9^{NS}	-	-	R^2= 0.004^{NS}	P= 0.443	1616.1	1455.2	142841.7
5.	Linearized Power	-	-396.7^{NS}	-	-	R^2= 0.018^{NS}	P= 0.140	2429.1	1911.5	178142.0
6.	Linearized Exponential	4.75x $10^{174\,NS}$	-0.19^{NS}	-	-	R^2= 0.018^{NS}	P= 0.140	2429.1	1911.5	178422.0
7.	Linearized Growth	402.2^{NS}	-0.19^{NS}	-	-	R^2= 0.018^{NS}	P= 0.140	2429.1	1911.5	178422.0
8.	Linearized S-curve	798 -391.3^{NS}	106.4^{NS}	-	-	R^2= 0.018^{NS}	P= 0.140	2429.1	1911.5	177862.0
9.	Exponential Smoothing	0.13	-	-	-	χ^2= 0.63	P< 0.000	1578.5	1371.6	136440.3
10.	ARIMA (2,0,0) (1,0,1) [12]	-	-	-	-	χ^2= 0.03	P< 0.000 AIC= 2112.2	1522.8	1330.4	131424.3

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.80, although many linearized models have significant R^2 values, the ARIMA(2,0,0)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2112.2), as indicated above, among various models fitted apart from lowest error measures like RMSE (1522.8), MAE (1330.4) and MAPE (131424.3). Thus, ARIMA model is chosen as best model for forecasting of linseed prices in Ramanujganj market.

4.18.3.4 Forecasting of Arrivals and Prices of Linseed in Ramanujganj Market

After identification of the model, forecasting of arrivals and prices of linseed has been done. The best ARIMA model has been used to forecast the arrivals and prices of linseed in Ramanujganj market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.81 and also depitcted in graph in Fig 4.54.

Table 4.81: Forecasted values of Arrivals and Prices of Linseed in Ramanujganj Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	39.08	57.62	1644.82	2113.78
February	121.75	57.64	2065.77	1640.42
March	39.03	57.62	2440.19	1560.65
April	54.65	57.63	1677.41	2030.62
May	54.27	57.63	2003.03	1848.86
June	40.14	57.62	1953.25	1882.65
July	56.00	57.63	2023.34	1842.44
August	41.79	57.63	1927.35	1903.05
September	37.38	57.62	1504.32	2166.56
October	46.97	57.63	1915.37	1911.35
November	71.32	57.63	2434.17	1589.06
December	40.77	57.63	1784.14	1993.08

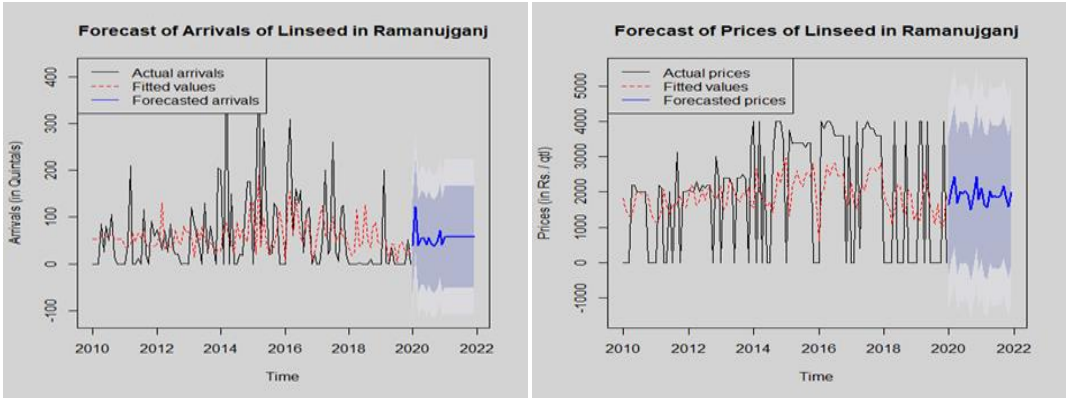


Fig. 4.54: Forecasts of Arrivals and Prices of Linseed in Ramanujganj

From the Table 4.18.3.3, the highest forecasted arrivals of linseed for Ramanujganj are expected to be 447.53 quintals and 372.29 quintals respectively in the month of November, 2020 and January, 2021 with respective forcasted prices to be Rs. 4127.09/quintal and Rs. 3356.11/quintal. However, the maximum prices were found to be Rs. 4127.09/quintal in the month of January, 2020 and Rs. 3356.11/quintal in the month of January, 2021.

4.19 Results for Arrivals and Prices of Oilseeds in Ambikapur Market

4.19.1 Groundnut

4.19.1.1 Trend in Arrivals and Prices of Groundnut in Ambikapur Market

Time series data for arrivals of groundnut in Ambikapur has been presented in Fig. 4.55: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 515 quintals in March 2012 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut have also been plotted over the observed time series.

The linearized trend in the arrivals of groundnut in Ambikapur has been indicated by dark-green line in the graph shown in Fig. 4.55: (e). It could be seen that the arrivals of groundnut in Ambikapur had shown an increasing trend over the years.

Similarly time series data for prices of groundnut in Ambikapur has been presented in Fig. 4.55: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 6395 in January 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Ambikapur has been indicated by dark-green line in the graph shown in Fig. 4.55: (f). It could be seen that the prices of groundnut in Ambikapur had shown an increasing trend over the years.

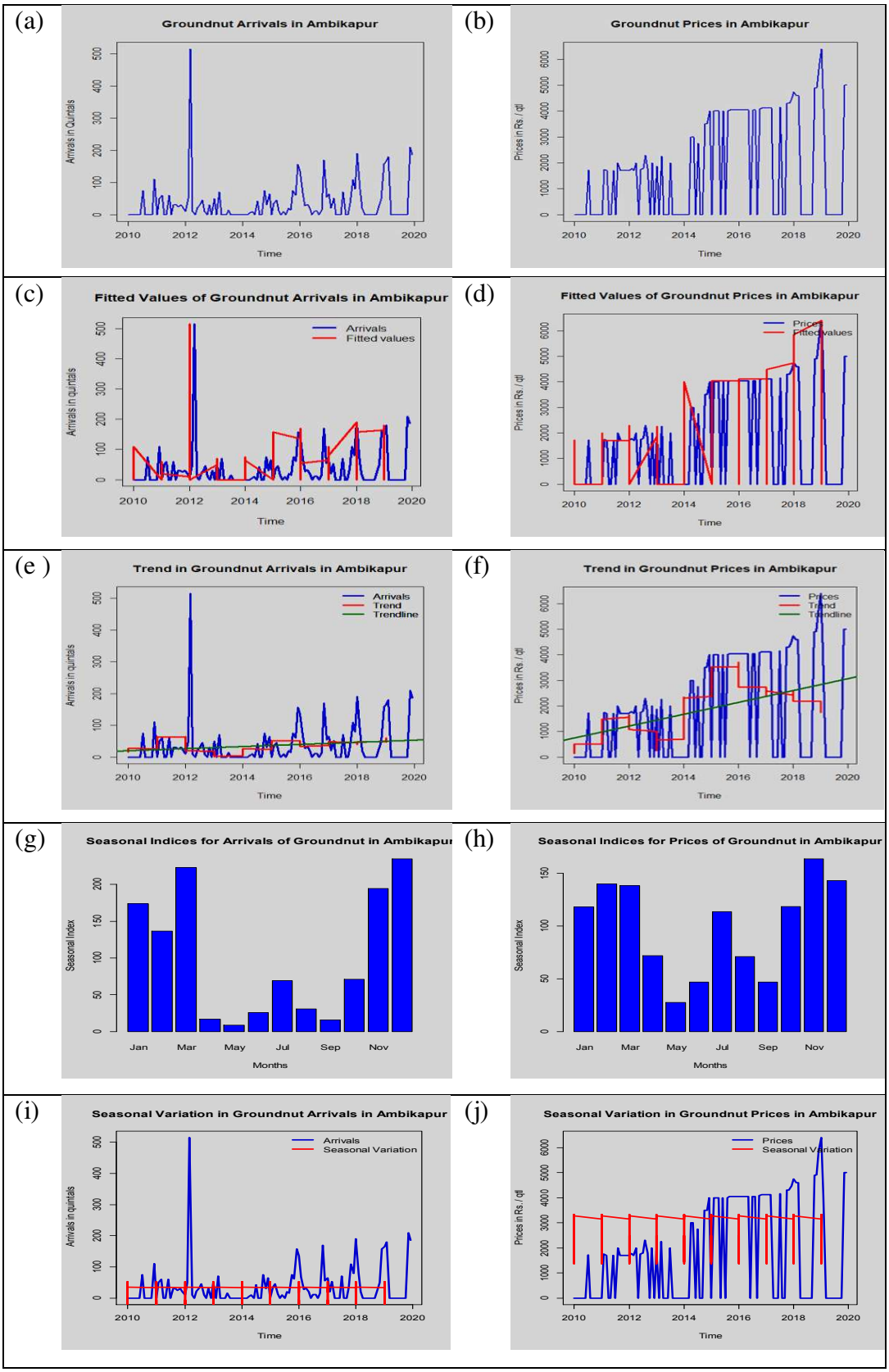


Fig. 4.55: Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Ambikapur Market

4.19.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Ambikapur Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.55: (g). The seasonal variation has been plotted in the graph of groundnut arrivals in Ambikapur.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.55: (h). The seasonal variation has been plotted in the graph of groundnut prices in Ambikapur.

4.19.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Ambikapur Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Ambikapur market were obtained as presented in the Table 4.82.

Table 4.82: Parameters of Fitted Model of Arrivals of Groundnut in Ambikapur

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-6585.9^{NS}	3.28 ^{NS}	-	-	R^2= 0.020 ^{NS}	P= 0.114	65.0	39.7	3301.4
	2nd order	175 6067 ^{NS}	-1746.6 ^{NS}	0.4 ^{NS}	-	R^2= 0.023 ^{NS}	P= 0.251	65.2	39.7	3372.6
	3rd order	19.5 ^{NS}	10.8 ^{NS}	-2.9 ^{NS}	0.2 ^{NS}	R^2= 0.027 ^{NS}	P= 0.350	65.3	39.6	3390.2
2.	Linearized Compound	2.87x 10^{-73} ^{NS}	1.08 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.259	72.1	35.6	5520.0
3.	Linearized Inverse	6654^{NS}	-1333 3144 ^{NS}	-	-	R^2= 0.020 ^{NS}	P= 0.114	65.0	39.7	3301.2
4.	Linearized Logarithmic	-50 330.3 ^{NS}	6619.9 ^{NS}	-	-	R^2= 0.020 ^{NS}	P= 0.114	65.0	39.7	3301.3
5.	Linearized Power	-	168.8 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.259	65.0	39.7	5520.0
6.	Linearized Exponential	2.87x 10^{-73} ^{NS}	0.08 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.259	65.0	39.7	5520.0
7.	Linearized Growth	-167 ^{NS}	0.08 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.259	65.0	39.7	5520.0
8.	Linearized S-curve	170.6^{NS}	-340 473.3 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.259	65.0	39.7	5520.0
9.	Exponential Smoothing	0.05	-	-	-	χ^2= 5.43	P< 0.000	66.5	38.2	2503.5

10.	ARIMA (1,0,0) (0,0,1) [12]	-	-	-	-	χ^2= 0.001	P< 0.000 AIC= 1335.6	60.8	35.4	2492.0
Note:- None of the Polynomial models are significant.										
Notations:-										
*	Significant at 5% level of Significance									
**	Significant at 1% level of Significance									
***	Significant at 0.1% level of Significance									
$	Significant at 10% level of Significance									

From the Table 4.82, although many linearized models have significant R^2 values, the ARIMA(1,0,0)(0,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1335.6), as indicated above, among various models fitted apart from lowest error measures like RMSE (60.8), MAE (35.4) and MAPE (2492.0). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Ambikapur market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Ambikapur market were obtained as presented in the Table 4.83.

Table 4.83: Parameters of Fitted Model of Prices of Groundnut in Ambikapur

S. N.	**Models**	**α**	**β_1**	**β_2**	**β_3**	**R^2 / Test-Statistics**	**P-value / AIC**	**RMSE**	**MAE**	**MAPE**
1.	Linearized Polynomial 1st order	-468 257.5***	233.3***	-	-	R^2= 0.121***	P< 0.000	1816.4	1647.9	164821.4
	2nd order	-2437 16988**	241 731.7**	-59.9**	-	R^2= 0.172***	P< 0.000	1770.0	1534.0	153431.4
	3rd order	486.7NS	-79.7NS	189.7 NS	-18.4*	R^2= 0.201***	P< 0.000	1746.6	1528.7	152896.3
2.	Linearized Compound	3.09x 10^{-157} NS	1.1 NS	-	-	R^2= 0.014 NS	P= 0.197	2604.1	1816.9	535722.2
3.	Linearized Inverse	472 219.2***	-9476 77789**	-	-	R^2= 0.121***	P< 0.000	1816.2	1647.7	164795.1
4.	Linearized Logarithmic	-357 5843***	470 238.4***	-	-	R^2= 0.121***	P< 0.000	1816.2	1647.7	164808.3
5.	Linearized Power	-	364.7NS	-	-	R^2= 0.014 NS	P= 0.197	2604.1	1816.9	535888.6
6.	Linearized Exponential	3.09x 10^{-157} NS	0.18 NS	-	-	R^2= 0.014 NS	P= 0.197	2604.1	1816.9	535722.2
7.	Linearized Growth	-360.3 NS	0.18 NS	-	-	R^2= 0.014 NS	P= 0.197	2604.1	1816.9	535722.2
8.	Linearized S-curve	69.1 NS	-735 891.3 NS	-	-	R^2= 0.014 NS	P= 0.197	2604.1	1816.9	536000.0
9.	Exponential Smoothing	0.49	-	-	-	χ^2= 0.23	P< 0.000	1742.3	1234.0	114372.5

10.	ARIMA (2,1,1) (1,0,0) [12]	-	-	-	-	χ^2= 0.03	P< 0.000 AIC= 2106.5	1600.1	1275.6	111752.5
Note:- Polynomial models upto 3rd order are significant.										
Notations:-										
*	Significant at 5% level of Significance									
**	Significant at 1% level of Significance									
***	Significant at 0.1% level of Significance									
$	Significant at 10% level of Significance									

From the Table 4.83, although many linearized models have significant R^2 values, the ARIMA(2,1,1)(1,0,0)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2106.5), as indicated above, among various models fitted apart from lowest error measures like RMSE (6.4), MAE (9.8) and MAPE (111752.5). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Ambikapur market.

4.19.1.4 Forecasting of Arrivals and Prices of Groundnut in Ambikapur Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Ambikapur market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.84 and also depitcted in graph in Fig 4.56.

Table 4.84: Forecasted values of Arrivals and Prices of Groundnut in Ambikapur Market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	82.92	42.62	4077.09	2662.66
February	78.98	37.18	3195.85	2448.00
March	27.83	36.15	1946.43	2143.95
April	27.48	35.96	1827.57	2114.94
May	27.42	35.93	1756.03	2097.49
June	27.60	35.92	1718.09	2088.23
July	29.38	35.92	1696.65	2083.00
August	27.52	35.92	1684.92	2080.13
September	27.61	35.92	1678.40	2078.54
October	26.07	35.92	1674.80	2077.66
November	88.39	35.92	2888.83	2372.92
December	71.51	35.92	2887.73	2372.65

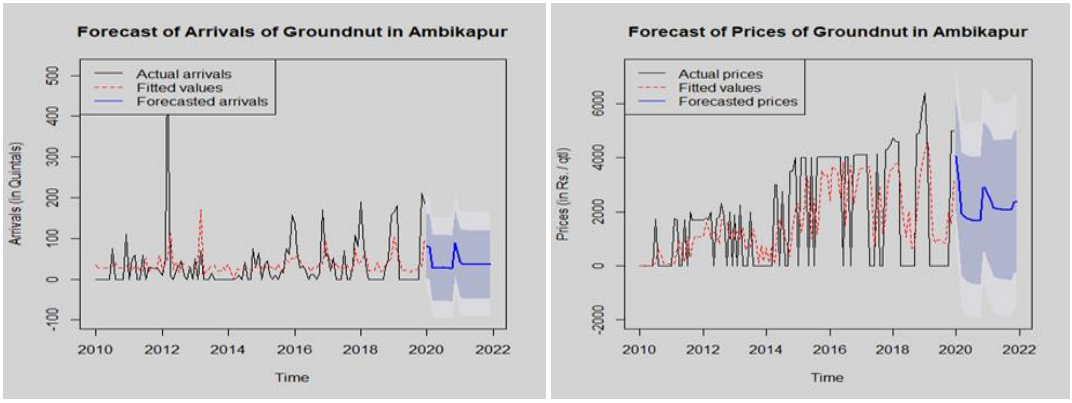


Fig. 4.56: Forecasts of arrivals and prices of groundnut in Ambikapur Market

From the Table 4.84, the highest forecasted arrivals of groundnut for Ambikapur are expected to be 88.39 quintals and 42.62 quintals respectively in the month of November, 2020 and January, 2021 with respective forcasted prices to be Rs. 2888.83/quintal and Rs. 2662.66/quintal. However, the maximum prices were found to be Rs. 4077.09/quintal in the month of January, 2020 and Rs. 2662.66/quintal in the month of January, 2021.

4.19.2 Sesame

4.19.2.1 Trend in Arrivals and Prices of Sesame in Ambikapur Market

Time series data for arrivals of sesame in Ambikapur has been presented in Fig. 4.57: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 1175 quintals in December 2019 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of sesame have also been plotted over the observed time series.

The linearized trend in the arrivals of sesame in Ambikapur has been indicated by dark-green line in the graph shown in Fig. 4.57: (e). It could be seen that the arrivals of sesame in Ambikapur had shown an increasing trend over the years.

Similarly time series data for prices of sesame in Ambikapur has been presented in Fig. 4.57: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs.19000 in January 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of sesame have also been plottted.

The linearized trend in the prices of sesame in Ambikapur has been indicated by dark-green line in the graph shown in Fig. 4.57: (f). It could be seen that the prices of sesame in Ambikapur had shown an increasing trend over the years.

4.19.2.2 Seasonality pattern in Arrivals and Prices of Sesame in Ambikapur Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.57: (g). The seasonal variation has been plotted in the graph of sesame arrivals in Ambikapur as shown there.

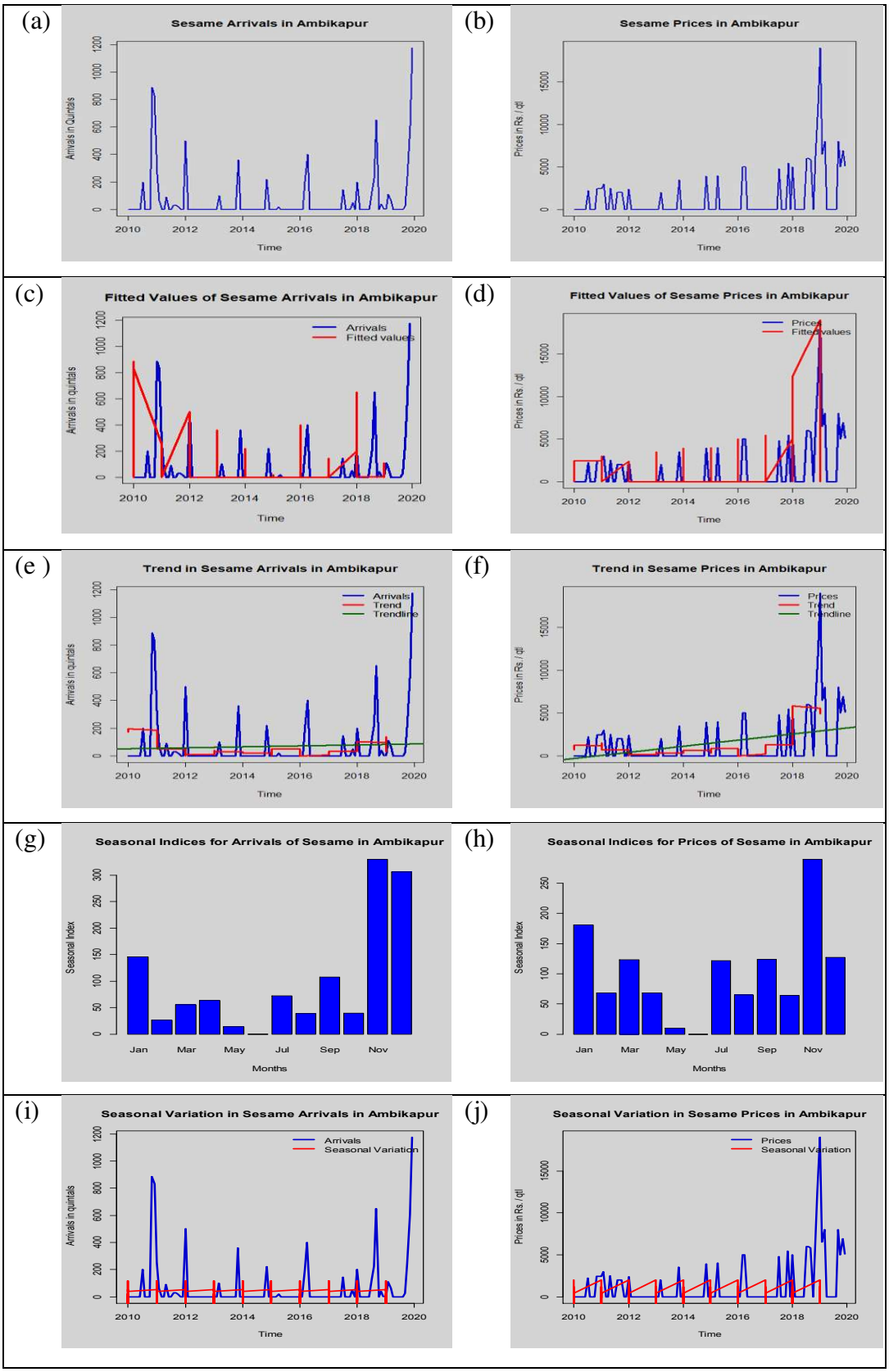


Fig. 4.57: Trend and Seasonality pattern in Arrivals and Prices of Sesame in Ambikapur Market

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.57: (h). The seasonal variation has been plotted in the graph of sesame prices in Ambikapur as shown there.

4.19.2.3 Identifying the Best Forecasting Model for Arrivals and Prices of Sesame in Ambikapur Market

By fitting different linear and non-linear time series models, we got following results for arrivals of sesame in Ambikapur market were obtained as presented in the Table 4.85.

Table 4.85: Parameters of Fitted Model of Arrivals of Sesame in Ambikapur Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-6824.3 ^{NS}	3.42 ^{NS}	-	-	R^2= 0.002^{NS}	P= 0.564	186.0	103.0	9720.8
	2nd order	300 59482**	-29846.5**	7.4**	-	R^2= 0.087**	P= 0.004	178.6	95.2	8301.8
	3rd order	134.6**	-55.1	5.0 ^{NS}	0.1 ^{NS}	R^2= 0.088**	P= 0.013	179.4	95.2	8282.0
2.	Linearized Compound	1.23 x10^{-76} ^{NS}	1.09 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.276	196.9	67.6	8326.3
3.	Linearized Inverse	6908.1 ^{NS}	-13784314 ^{NS}	-	-	R^2= 0.002 ^{NS}	P= 0.566	186.0	103.1	9721.8
4.	Linearized Logarithmic	-52173.9 ^{NS}	686627 ^{NS}	-	-	R^2= 0.002 ^{NS}	P= 0.566	186.0	103.1	9721.3
5.	Linearized Power	-	175.15 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.276	196.9	67.6	8326.3
6.	Linearized Exponential	1.23 x10^{-76} ^{NS}	0.08 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.276	196.9	67.6	8326.3
7.	Linearized Growth	-174.7 ^{NS}	0.08 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.276	196.9	67.6	8326.3
8.	Linearized S-curve	175.5^{NS}	-352184.5 ^{NS}	-	-	R^2= 0.010 ^{NS}	P= 0.276	196.9	67.6	8326.3
9.	Exponential Smoothing	0.77	-	-	-	χ^2= 0.189	P< 0.000	172.9	81.5	8325.4
10.	ARIMA (2,0,2) (1,0,1) [12]	-	-	-	-	χ^2= 0.003	P< 0.000 AIC= 1567.6	159.8	88.1	8229.5

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.85, although many linearized models have significant R^2 values, the ARIMA(2,0,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1567.6), as indicated above, among various models fitted apart from lowest error measures like RMSE (159.8), MAE (88.1) and MAPE (8229.5). Thus, ARIMA model is chosen as best model for forecasting of sesame arrivals in Ambikapur market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of sesame in Ambikapur market were obtained as presented in the Table 4.86.

Table 4.86: Parameters of Fitted Model of Prices of Sesame in Ambikapur Market

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-719 396.8***	357.7***	-	-	R^2= 0.132***	P< 0.000	2648.2	1864.8	191014.4
	2nd order	52940 4581***	-525 951.6***	130.6***	-	R^2= 0.246***	P< 0.000	2479.7	1555.9	155802.4
	3rd order	712.5NS	196.0 NS	-166.2 NS	21.9$	R^2= 0.264***	P< 0.000	2459.2	1525.5	152502.6
2.	Linearized Compound	3.14x $10^{-210\$}$	1.27$	-	-	R^2= 0.030$	P= 0.057	3130.8	1333.7	907745.2
3.	Linearized Inverse	72 117.3***	-1450 171354***	-	-	R^2= 0.132***	P< 0.000	2648.7	1865.3	191072.5
4.	Linearized Logarithmic	-547 8724***	720287***	-	-	R^2= 0.132***	P< 0.000	2648.5	1865.1	191043.5
5.	Linearized Power	-	483.4$	-	-	R^2= 0.030$	P= 0.057	3130.8	1333.7	907745.2
6.	Linearized Exponential	3.14x $10^{-210\$}$	0.24$	-	-	R^2= 0.030$	P= 0.057	3130.8	1333.7	907745.2
7.	Linearized Growth	-482.3$	0.24$	-	-	R^2= 0.030$	P= 0.057	3130.8	1333.7	907232.1
8.	Linearized S-curve	484.5$	-972 796.5$	-	-	R^2= 0.030$	P= 0.057	3130.8	1333.7	907232.1
9.	Exponential Smoothing	0.50	-	-	-	χ^2= 1.072	P< 0.000	2494.0	1333.7	118101.1
10.	ARIMA (1,1,1) (1,0,1) [12]	-	-	-	-	χ^2= 0.023	P< 0.000 AIC= 2184.4	2213.0	1365.6	111254.8

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.86, although many linearized models have significant R^2 values, the ARIMA(1,1,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=2184.4), as indicated above, among various models fitted apart from lowest error measures like RMSE (2213.0), MAE (1365.6) and MAPE (111254.8). Thus, ARIMA model is chosen as best model for forecasting of sesame prices in Ambikapur market.

4.19.2.4 Forecasting of Arrivals and Prices of Sesame in Ambikapur Market

After identification of the model, forecasting of arrivals and prices of sesame has been done. The best ARIMA model has been used to forecast the arrivals and prices of sesame in Ambikapur market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.87 and also depitcted in graph in Fig 4.58.

Table 4.87: Forecasted values of Arrivals and Prices of Sesame in Ambikapur Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	684.17	35.60	7383.54	1522.50
February	297.55	57.04	4524.74	2644.32
March	57.06	71.17	4835.23	2708.25
April	38.47	72.74	2211.20	3513.08
May	65.63	71.20	2527.04	3457.79
June	77.15	70.54	2526.24	3473.51
July	75.69	70.45	1838.38	3673.23
August	73.43	70.49	1137.79	3872.65
September	67.90	70.09	4116.55	3040.81
October	61.13	69.49	4401.36	2961.87
November	39.91	67.65	4350.85	2976.35
December	7.76	64.88	1468.49	3782.98

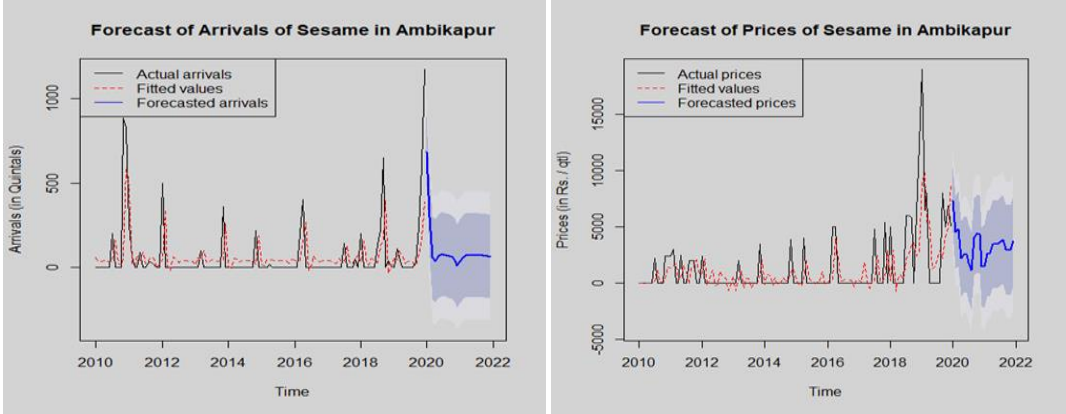


Fig. 4.58: Forecasts of Arrivals and Prices of Sesame in Ambikapur Market

From the Table 4.87, the highest forecasted arrivals of sesame for Ambikapur are expected to be 684.17 quintals and 72.74 quintals respectively in the month of January, 2020 and April, 2021 with respective forcasted prices to be Rs. 7383.54/quintal and Rs. 3513.08/quintal. However, the maximum prices were found to be Rs. 7383.54/quintal in the month of January, 2020 and Rs. 3832.65/quintal in the month of August, 2021.

4.20 Results for Arrivals and Prices of Oilseeds in Pratappur Market

4.20.1 Groundnut

4.20.1.1 Trend in Arrivals and Prices of Groundnut in Pratappur Market

Time series data for arrivals of groundnut in Pratappur has been presented in Fig. 4.59: (a)-(c)-(e)-(g)-(i). The maximum arrival observed was 826 quintals in September 2014 and minimum 0 quintal in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values for the arrivals of groundnut have also been plotted over the observed time series.

The linearized trend in the arrivals of groundnut in Pratappur has been indicated by dark-green line in the graph shown in Fig. 4.59: (e). It could be seen that the arrivals of groundnut in Pratappur had shown an increasing trend over the years.

Similarly time series data for prices of groundnut in Pratappur has been presented in Fig. 4.59: (b)-(d)-(f)-(h)-(j). The maximum price observed was Rs. 5100 in December 2019 and minimum is Rs. 0 in some of the months since no arrival took place in that months. In this case, additive model is appropriate to describe this time series because there is no continuous increase/decrease in amplitudes with increasing time. The fitted values of prices of groundnut have also been plottted.

The linearized trend in the prices of groundnut in Pratappur has been indicated by dark-green line in the graph shown in Fig. 4.59: (f). It could be seen that the prices of groundnut in Pratappur had shown an increasing trend over the years.

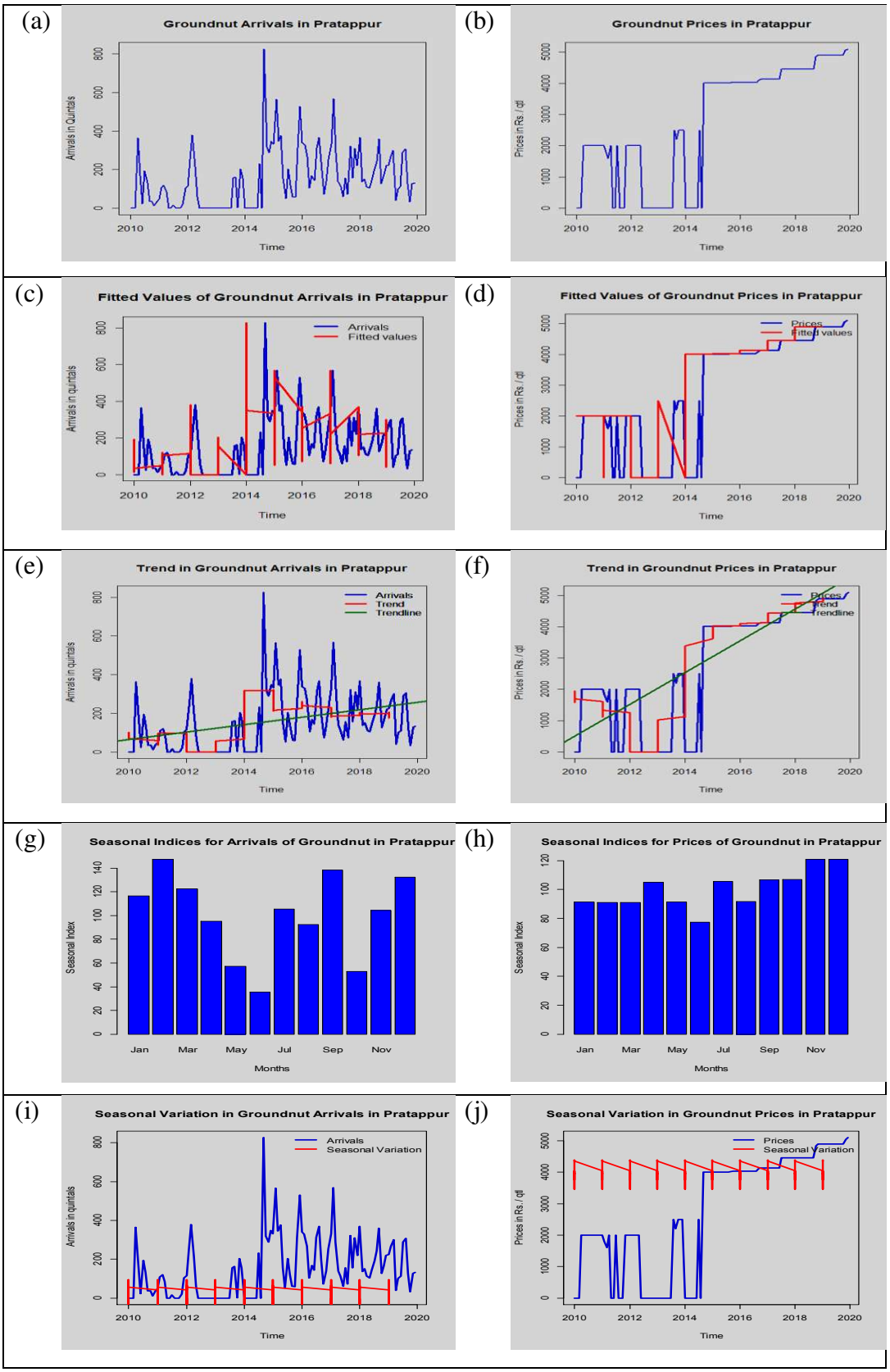


Fig. 4.59 : Trend and Seasonality pattern in Arrivals and Prices of Groundnut in Pratappur Market

4.20.1.2 Seasonality pattern in Arrivals and Prices of Groundnut in Pratappur Market

The patterns of variation in arrivals within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.59: (g). The seasonal variation has been plotted in the graph of groundnut arrivals in Pratappur.

The patterns of variation in prices within a year as revealed by the seasonal indices were computed for each month. The graph of the monthly seasonal indices as shown in Fig. 4.59: (h). The seasonal variation has been plotted in the graph of groundnut prices in Pratappur.

4.20.1.3 Identifying the Best Forecasting Model for Arrivals and Prices of Groundnut in Pratappur Market

By fitting different linear and non-linear time series models, we got following results for arrivals of groundnut in Pratappur market were obtained as presented in the Table 4.88.

Table 4.88: Parameters of Fitted Model of Arrivals of Groundnut in Pratappur

S. N.	Models	α	β_1	β_2	β_3	R^2 / Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial									
	1st order	-3855.1***	19.1***	-	-	R^2= 0.13***	P< 0.000	140.2	107.3	5417.8
	2nd order	-132 86280$	13171.6$	-3.2$	-	R^2= 0.16***	P< 0.000	138.7	105.4	5723.0
	3rd order	73.1*	-38.4NS	22.2*	-1.8**	R^2= 0.21***	P< 0.000	135.1	103.1	4789.2
2.	Linearized Compound	0***	1.5***	-	-	R^2= 0.24***	P< 0.000	172.7	113.7	8717.0
3.	Linearized Inverse	38828.1***	-7791 4651***	-	-	R^2= 0.13***	P< 0.000	140.1	107.3	5417.6
4.	Linearized Logarithmic	-29 4029.5***	38666.6***	-	-	R^2= 0.13***	P< 0.000	140.1	107.3	5417.7
5.	Linearized Power	-	880.7***	-	-	R^2= 0.24***	P< 0.000	172.7	113.7	8721.0
6.	Linearized Exponential	0***	0.43***	-	-	R^2= 0.24***	P< 0.000	172.7	113.7	8717.0
7.	Linearized Growth	-877.1***	0.43***	-	-	R^2= 0.24***	P< 0.000	172.7	113.7	8717.0
8.	Linearized S-curve	884.2***	-177 4026***	-	-	R^2= 0.24***	P< 0.000	172.7	113.7	8726.0
9.	Exponential Smoothing	0.40	-	-	-	χ^2= 1.61	P< 0.000	134.09	89.5	1796.3

10.	ARIMA (0,1,3) (1,0,1) [12]	-	-	-	-	χ^2= 0.01	P< 0.000 AIC= 1499.9	125.6	84.5	2038.7

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.88, although many linearized models have significant R^2 values, the ARIMA(0,1,3)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1499.9), as indicated above, among various models fitted apart from lowest error measures like RMSE (125.6), MAE (84.5) and MAPE (2038.7). Thus, ARIMA model is chosen as best model for forecasting of groundnut arrivals in Pratappur market.

Similarly, by fitting different linear and non-linear time series models as indicated above, following results for prices of groundnut in Pratappur market were obtained as presented in the Table 4.89.

Table 4.89: Parameters of Fitted Model of Prices of Groundnut in Pratappur

S. N.	Models	α	β_1	β_2	β_3	R^2/ Test-Statistics	P-value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-102 1280***	508.3***	-	-	R^2= 0.63***	P< 0.000	1122.8	864.4	81779.0
	2nd order	1116 14642***	-111 317.1***	27.7***	-	R^2= 0.64***	P< 0.000	1109.0	920.8	79189.5
	3rd order	1563.6***	-1078.5***	419.3***	-29***	R^2= 0.72***	P< 0.000	985.7	785.3	64976.1
2.	Linearized Compound	0***	1.9***	-	-	R^2= 0.23***	P< 0.000	2178.0	1825.2	81811.9
3.	Linearized Inverse	102 6673***	-2062 613191***	-	-	R^2= 0.63***	P< 0.000	1123.2	863.9	81795.4
4.	Linearized Logarithmic	-778 7753***	102 3976***	-	-	R^2= 0.63***	P< 0.000	1123.2	863.9	67581.1
5.	Linearized Power	-	1301.38***	-	-	R^2= 0.23***	P< 0.000	1123.2	863.9	67511.1
6.	Linearized Exponential	0***	0.64***	-	-	R^2= 0.23***	P< 0.000	1123.2	863.9	67511.1
7.	Linearized Growth	-1295.6***	0.64***	-	-	R^2= 0.23***	P< 0.000	1123.2	863.9	67652.1
8.	Linearized S-curve	1307.1***	-262 1156***	-	-	R^2= 0.23***	P< 0.000	1123.2	863.9	67652.1
9.	Exponential Smoothing	0.70	-	-	-	χ^2= 0.236	P< 0.000	705.8	280.5	21226.7

10.	ARIMA (1,1,0) (1,0,1) [12]	-	-	-	-	χ^2= 0.013	P< 0.000 AIC= 1904.9	696.7	280.5	20707.7

Note:- Polynomial models upto 3rd order are significant.

Notations:-
* Significant at 5% level of Significance
** Significant at 1% level of Significance
*** Significant at 0.1% level of Significance
$ Significant at 10% level of Significance

From the Table 4.89, although many linearized models have significant R^2 values, the ARIMA(1,1,0)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) with (AIC=1904.9), as indicated above, among various models fitted apart from lowest error measures like RMSE (6.4), MAE (9.8) and MAPE (20707.7). Thus, ARIMA model is chosen as best model for forecasting of groundnut prices in Pratappur market.

4.20.1.3 Forecasting of Arrivals and Prices of Groundnut in Pratappur Market

After identification of the model, forecasting of arrivals and prices of groundnut has been done. The best ARIMA model has been used to forecast the arrivals and prices of groundnut in Pratappur market for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 4.90 and also depitcted in graph in Fig 4.60.

Table 4.90 Forecasted values of Arrivals and Prices of Groundnut in Pratappur Market

Months	**Predicted Arrivals (quintals)**		**Predicted Prices (Rs./quintal)**	
	2020	**2021**	**2020**	**2021**
January	186.48	197.32	5084.21	5066.93
February	199.50	208.13	5089.44	5066.62
March	193.43	193.22	5087.75	5066.72
April	160.54	163.89	5088.29	5066.69
May	150.85	155.25	5088.13	5066.70
June	143.78	148.95	5088.21	5066.71
July	185.50	186.14	5086.04	5066.18
August	181.34	182.44	5086.32	5066.25
September	200.38	199.41	5085.58	5066.07
October	148.01	152.72	5078.61	5064.35
November	180.22	181.44	5068.82	5061.94
December	193.37	193.16	5065.89	5061.22

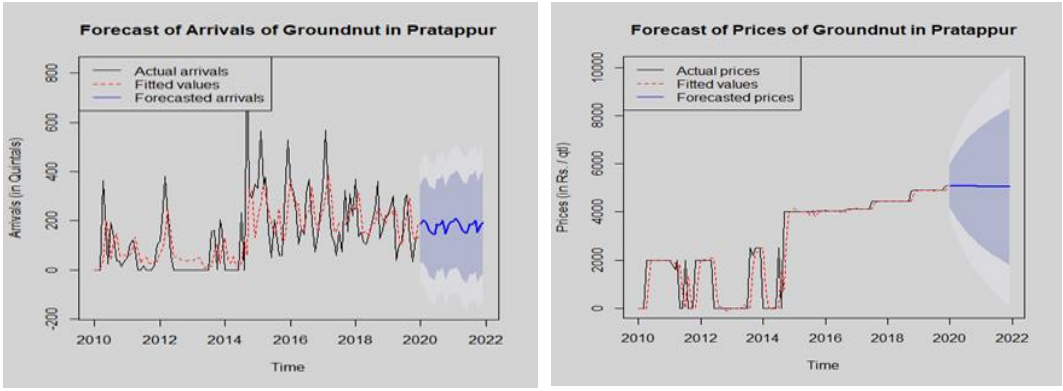


Fig. 4.60: Forecasts of Arrivals and Prices of Groundnut in Pratappur Market

From the Table 4.90, the highest forecasted arrivals of groundnut for Pratappur are expected to be 684.17 quintals and 72.74 quintals respectively in the month of January, 2020 and April, 2021 with respective forcasted prices to be Rs. 7383.54/quintal and Rs. 3513.08/quintal. However, the maximum prices were found to be Rs. 7383.54/quintal in the month of January, 2020 and Rs. 3832.65/quintal in the month of August, 2021.

CHAPTER – V
SUMMARY AND CONCLUSIONS

Summary:

Indian Agriculture is one of the most significant contributors to the Indian socio-economic sector. Oilseed crops forms an important component of crop diversification and plays significant role in the commercialization of agriculture. In India agricultural marketing is done through Agricultural Markets (*Mandis*). Presently, 69 agricultural markets (*Mandis*) are working in Chhattisgarh. For the development of agriculture it is quite necessary that farmers get good prices of their products in the agricultural markets.

This study aims at forecating arrivals and prices of 20 agricultural markets of Chhattisgarh for oilseeds, where data could be obtained, based on various statistical models. Using these data, different linear, non-linear and time series models have been fitted. The ARIMA model has been found to be the best model for forecasting of arrivals and prices of different oilseeds in all the 20 markets. In this study, Statistical analyses have been carried out using the powerful software "R: The Project for Statistical Computing." Step wise conclusion is given below separately.

Conclusions:

Stepwise conclusions for different markets as per objectives of the study are concluded below:

S.N.	Market	Crop	Parameter	Parameter inference
1.1	Kawardha	Soybean	Arrivals	Decreasing trend.
			Prices	Decreasing trend.
			Best Model	ARIMA(1,0,0)(0,0,1)[12] for arrivals and ARIMA(1,0,0)(0,0,1)[12] for prices have significant Ljung-Box test.

			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	10286.94 quintals in November, 2020 and 7418.86 quintals in January, 2021.
			Correspond-ing Prices to Forecast	Rs 3435.18/quintal in November, 2020 and Rs.3494.74/quintal in January, 2021.
			Maximum Prices	Rs.3557.91/quintal in January, 2020 and Rs.3494.74/quintal in January, 2021.
			Conclusion	Forecasted prices corresponding to highest arrivals are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
2.1	Bemetara	Soybean	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(2,1,2)(1,0,1)[12] for arrivals and ARIMA(0,1,1)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted	18365.74 quintals in November, 2020 and

			Arrivals	17519.00 quintals in November, 2021.
			Correspond-ing Prices to Forecast	Rs. 3613.92/quintal in November, 2020 and Rs. 3738.00/quintal in November, 2021.
			Maximum Prices	Rs. 3858.10/quintal in May, 2020 and Rs. 3967.78/quintal in May, 2021.
			Conclusion	Forecasted prices are moderately close to the maximum prices within a close variation of months. In this case the farmers would be moderately benefitted.
3.1	Bhatapara	Soybean	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(2,0,2)(1,0,1)[12] for arrivals and ARIMA(2,0,2)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	935.64 quintals in November, 2020 and 932.17 quintals in November, 2021.
			Correspond-ing Prices to	Rs. 3164.78/quintal in November, 2020 and

			Forecast	Rs. 3147.88/quintal in November, 2021.
			Maximum Prices	Rs. 3257.21/quintal in January, 2020 and Rs. 3151.05/quintal in March, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
3.2	Bhatapara	Mustard	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(1,1,1)(1,0,0)[12] for arrivals and ARIMA(0,1,2)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	2161.92 quintals in May, 2020 and 1605.38 quintals in May, 2021.
			Correspond-ing Prices to Forecast	Rs. 3482.23/quintal in May, 2020 and Rs. 3429.75/quintal in May, 2021.
			Maximum	Rs. 3532.01/quintal in January,

			Prices	2020 and Rs. 3471.59/quintal in June, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
4.1	Basna	Groundnut	Arrivals	Decreasing trend.
			Prices	Decreasing trend.
			Best Model	ARIMA(0,0,1)(1,0,2)[12] for arrivals and ARIMA(0,0,2)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	376.85 quintals in April, 2020 and 242 quintals in June, 2021.
			Correspond-ing Prices to Forecast	Rs. 3482.23/quintal in April, 2020 and Rs. 3429.75/quintal in June, 2021.
			Maximum Prices	Rs. 2607.45/quintal in November, 2020 and Rs. 2574.54/quintal in November, 2021.

			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
5.1	Rajnandgaon	Soybean	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(1,0,0)(1,0,1)[12] for arrivals and ARIMA(2,1,2)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	9026.21 quintals in January, 2020 and 6510.88 quintals in August, 2021.
			Correspond-ing Prices to Forecast	Rs. 4027.78/quintal in January, 2020 and Rs. 4048.60/quintal in August, 2021.
			Maximum Prices	Rs. 4027.78/quintal in January, 2020 and Rs. 4054.93/quintal in January, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to

				maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
5.2	Rajnandgaon	Linseed	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(2,1,1)(1,0,1)[12] for arrivals and ARIMA(2,1,2)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	457.17 quintals in June, 2020 and 476.34 quintals in June, 2021.
			Correspond-ing Prices to Forecast	Rs. 4324.67/quintal in June, 2020 and Rs. 4199.20/quintal in June, 2021.
			Maximum Prices	Rs. 4440.20/quintal in January, 2020 and Rs. 4235.27/quintal in January, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.

5.3	Rajnandgaon	Mustard	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(1,1,1)(0,1,0)[12] for arrivals and ARIMA(2,1,2)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	1753.12 quintals in April, 2020 and 1853.82 quintals in April, 2021.
			Correspond-ing Prices to Forecast	Rs. 3291.61/quintal in April, 2020 and Rs. 3249.53/quintal in April, 2021.
			Maximum Prices	Rs. 3463.51/quintal in November, 2020 and Rs. 3285.22/quintal in November, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
6.1	Khairagarh	Soybean	Arrivals	Decreasing trend.
			Prices	Decreasing trend.

			Best Model	ARIMA(1,1,1)(2,0,0)[12] for arrivals and ARIMA(1,0,3)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	6963.03 quintals in October, 2020 and 9035.44 quintals in November, 2021.
			Correspond-ing Prices to Forecast	Rs. 2525.74/quintal in October, 2020 and Rs. 2280.33/quintal in November, 2021.
			Maximum Prices	Rs. 2923.98/quintal in January, 2020 and Rs. 2560.76/quintal in March, 2021.
			Conclusion	Forecasted prices are moderately close to the maximum prices within a close variation of months. In this case the farmers would be moderately benefitted.
7.1	Gandai	Soybean	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(2,0,2)(1,0,1)[12] for arrivals and ARIMA(2,1,2)(1,0,1)[12] for prices have significant Ljung-Box test.

			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	3825.07 quintals in January, 2020 and 4353.45 quintals in November, 2021.
			Correspond-ing Prices to Forecast	Rs. 3126.61/quintal in January, 2020 and Rs. 3105.91/quintal in November, 2021.
			Maximum Prices	Rs. 3162.73/quintal in January, 2020 and Rs. 3121.46/quintal in January, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
8.1	Dongargaon	Soybean	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(0,1,2)(1,0,1)[12] for arrivals and ARIMA(2,1,2)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted	42290.57 quintals in October,

			Arrivals	2020 and 40499.00 quintals in October, 2021.
			Correspond-ing Prices to Forecast	Rs. 3896.08/quintal in October, 2020 and Rs. 3924.32/quintal in October, 2021.
			Maximum Prices	Rs. 3935.74/quintal in January, 2020 and Rs. 3928.96/quintal in January, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
9.1	Raipur	Mustard	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(2,1,2)(1,0,1)[12] for arrivals and ARIMA(0,1,1)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	217.86 quintals in March, 2020 and 217.47 quintals in March, 2021.

			Correspond-ing Prices to Forecast	Rs. 2997.56/quintal in March, 2020 and Rs. 3144.38/quintal in March, 2021.
			Maximum Prices	Rs. 3182.87/quintal in June, 2020 and Rs. 3165.60/quintal in June, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
10.1	Champa	Groundnut	Arrivals	Decreasing trend.
			Prices	Decreasing trend.
			Best Model	ARIMA(0,1,1)(1,0,0)[12] for arrivals and ARIMA(1,0,1)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	3.56 quintals in May, 2020 and 2.69 quintals in May, 2021.
			Correspond-ing Prices to Forecast	Rs. 2293.15/quintal in May, 2020 and Rs. 2409.44/quintal in May, 2021.

			Maximum Prices	Rs. 3185.87/quintal in February, 2020 and Rs. 2976.13/quintal in March, 2021.
			Conclusion	Forecasted prices are far less than the maximum prices within close months. Such a case is not beneficial to the farmers.
10.2	Champa	Mustard	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(0,0,0)(0,0,1)[12] for arrivals and ARIMA(3,1,2)(2,0,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	24.35 quintals in November, 2020 and 4.20 quintals in November, 2021.
			Correspond-ing Prices to Forecast	Rs. 2265.28/quintal in November, 2020 and Rs. 2195.18/quintal in November, 2021.
			Maximum Prices	Rs. 3645.53/quintal in May, 2020 and Rs. 2976.13/quintal in May, 2021.

			Conclusion	Forecasted prices are far less than the maximum prices within close months. Such a case is not beneficial to the farmers.
11.1	Pendra Road	Linseed	Arrivals	Decreasing trend.
			Prices	Decreasing trend.
			Best Model	ARIMA(1,0,0)(1,0,1)[12] for arrivals and ARIMA(1,0,1)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	55.40 quintals in January, 2020 and 44.99 quintals in January, 2021.
			Correspond-ing Prices to Forecast	Rs. 1692.54/quintal in January, 2020 and Rs. 1123.47/quintal in January, 2021.
			Maximum Prices	Rs. 1692.54/quintal in January, 2020 and Rs. 1399.91/quintal in June, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a

				case is very beneficial to the farmers.
12.1	Mungeli	Soybean	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(1,0,0)(0,1,1)[12] for arrivals and ARIMA(0,1,0)(2,0,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	21332.96 quintals in November, 2020 and 21333.64 quintals in November, 2021.
			Correspond-ing Prices to Forecast	Rs. 3790.62/quintal in November, 2020 and Rs. 3890.87/quintal in November, 2021.
			Maximum Prices	Rs. 3861.06/quintal in April, 2020 and Rs. 3941.61/quintal in September, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
13.1	Gharghoda	Groundnut	Arrivals	Decreasing trend.

			Prices	Increasing trend.
			Best Model	ARIMA(0,0,0)(1,1,0)[12] for arrivals and ARIMA(0,0,2)(2,1,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	338.40 quintals in August, 2020 and 367.36 quintals in August, 2021.
			Correspond-ing Prices to Forecast	Rs. 3983.83/quintal in August, 2020 and Rs. 4082.93/quintal in August, 2021.
			Maximum Prices	Rs. 4167.23/quintal in November, 2020 and Rs. 4174.60/quintal in November, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
14.1	Raigarh	Groundnut	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(1,0,0)(1,0,0)[12] for arrivals and

				ARIMA(1,1,1)(2,0,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	183.45 quintals in January, 2020 and 144.42 quintals in January, 2021.
			Correspond-ing Prices to Forecast	Rs. 2609.61/quintal in January, 2020 and Rs. 3055.55/quintal in January, 2021.
			Maximum Prices	Rs. 3438.41/quintal in August, 2020 and Rs. 3258.75/quintal in August, 2021.
			Conclusion	Forecasted prices are far less than the maximum prices within close months. Such a case is not beneficial to the farmers.
15.1	Baikunthpur	Mustard	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(0,1,1)(1,0,0)[12] for arrivals and ARIMA(3,1,1)(1,0,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.

			Highest Forecasted Arrivals	17.45 quintals in September, 2020 and 13.36 quintals in September, 2021.
			Correspond-ing Prices to Forecast	Rs. 2594.80/quintal in September, 2020 and Rs. 2590.24/quintal in September, 2021.
			Maximum Prices	Rs. 2684.37/quintal in October, 2020 and Rs. 2468.66/quintal in June, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
16.1	Patthalgaon	Groundnut	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(0,0,2)(0,1,0)[12] for arrivals and ARIMA(1,1,1)(0,1,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	1308.00 quintals in November, 2020 and 1308.00 quintals in November,

				2021.
			Correspond-ing Prices to Forecast	Rs. 4660.76/quintal in November, 2020 and Rs. 4657.59/quintal in November, 2021.
			Maximum Prices	Rs. 5010.06/quintal in February, 2020 and Rs. 5006.67/quintal in February, 2021.
			Conclusion	Forecasted prices are moderately close to the maximum prices within a close variation of months. In this case the farmers would be moderately benefitted.
16.2	Patthalgaon	Mustard	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(1,0,1)(1,0,1)[12] for arrivals and ARIMA(1,1,1)(1,0,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	15.85 quintals in August, 2020 and 15.64 quintals in August, 2021.
			Correspond-ing Prices to Forecast	Rs. 3241.73/quintal in August, 2020 and Rs. 2689.29/quintal in August, 2021.

			Maximum Prices	Rs. 3414.54/quintal in September, 2020 and Rs. 2789.74/quintal in September, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
17.1	Jashpurnagar	Groundnut	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(0,0,1)(1,0,1)[12] for arrivals and ARIMA(2,1,2)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	98.30 quintals in November, 2020 and 97.94 quintals in November, 2021.
			Correspond-ing Prices to Forecast	Rs. 3829.62/quintal in November, 2020 and Rs. 3877.19/quintal in November, 2021.
			Maximum Prices	Rs. 3829.62/quintal in November, 2020 and Rs. 3877.19/quintal in

				November, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are equal to maximum prices. Such a case is very beneficial to the farmers.
17.2	Jashpurnagar	Sesame	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(2,0,2)(1,0,0)[12] for arrivals and ARIMA(3,1,2)(0,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	172.74 quintals in July, 2020 and 149.62 quintals in December, 2021.
			Correspond-ing Prices to Forecast	Rs. 1261.16/quintal in July, 2020 and Rs. 2025.44/quintal in Deceember, 2021.
			Maximum Prices	Rs. 4515.43/quintal in January, 2020 and Rs. 2285.32/quintal in March, 2021.
			Conclusion	Forecasted prices are less close to the maximum prices within a close variation of months. Such a case is least beneficial

				to the farmers.
17.3	Jashpurnagar	Mustard	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(0,0,0)(1,0,1)[12] for arrivals and ARIMA(0,1,1)(1,0,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	20.00 quintals in September, 2020 and 17.03 quintals in November, 2021.
			Correspond-ing Prices to Forecast	Rs. 3195.90/quintal in September, 2020 and Rs. 2977.49/quintal in November, 2021.
			Maximum Prices	Rs. 3266.91/quintal in March, 2020 and Rs. 2996.77/quintal in March, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
18.1	Ramanuj-	Groundnut	Arrivals	Increasing trend.

	ganj		Prices	Increasing trend.
			Best Model	ARIMA(1,0,0)(1,1,0)[12] for arrivals and ARIMA(1,0,0)(1,1,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	96.89 quintals in January, 2020 and 97.50 quintals in January, 2021.
			Correspond-ing Prices to Forecast	Rs. 3936.84/quintal in January, 2020 and Rs. 4032.45/quintal in January, 2021.
			Maximum Prices	Rs. 4853.66/quintal in May, 2020 and Rs. 4858.26/quintal in May, 2021.
			Conclusion	Forecasted prices are far less than the maximum prices within close months. Such a case is not beneficial to the farmers.
18.2	Ramanuj-ganj	Sesame	Arrivals	Decreasing trend.
			Prices	Decreasing trend.
			Best Model	ARIMA(1,0,0)(2,0,0)[12] for arrivals and ARIMA(1,1,1)(1,0,1)[12] for prices have significant Ljung-

				Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	447.53 quintals in November, 2020 and 372.29 quintals in November, 2021.
			Correspond-ing Prices to Forecast	Rs. 4127.09/quintal in November, 2020 and Rs. 3356.11/quintal in November, 2021.
			Maximum Prices	Rs. 4127.09/quintal in November, 2020 and Rs. 3356.11/quintal in November, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are equal to maximum prices. Such a case is very beneficial to the farmers.
18.3	Ramanuj-ganj	Linseed	Arrivals	Decreasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(0,0,0)(0,0,1)[12] for arrivals and ARIMA(2,0,0)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted	121.75 quintals in February, 2020 and 57.64 quintals in

			Arrivals	February, 2021.
			Correspond-ing Prices to Forecast	Rs. 2065.77/quintal in February, 2020 and Rs. 1640.42/quintal in February, 2021.
			Maximum Prices	Rs. 2440.19/quintal in March, 2020 and Rs. 2166.56/quintal in September, 2021.
			Conclusion	Forecasted prices are moderately close to the maximum prices within a close variation of months. In this case the farmers would be moderately benefitted.
19.1	Ambikapur	Groundnut	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(1,0,0)(0,0,1)[12] for arrivals and ARIMA(2,1,1)(1,0,0)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	88.39 quintals in November, 2020 and 42.62 quintals in January, 2021.
			Correspond-ing Prices to Forecast	Rs. 2888.83/quintal in November, 2020 and Rs. 2662.66/quintal in January, 2021.

			Maximum Prices	Rs. 4077.09/quintal in January, 2020 and Rs. 2662.66/quintal in January, 2021.
			Conclusion	Forecasted prices are far less than the maximum prices within close months. Such a case is not beneficial to the farmers.
19.2	Ambikapur	Sesame	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(2,0,2)(1,0,1)[12] for arrivals and ARIMA(1,1,1)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	684.17 quintals in January, 2020 and 72.74 quintals in April, 2021.
			Correspond-ing Prices to Forecast	Rs. 7383.54/quintal in January, 2020 and Rs. 3513.08/quintal in April, 2021.
			Maximum Prices	Rs. 7383.54/quintal in January, 2020 and Rs. 3832.65/quintal in August, 2021.
			Conclusion	Forecasted prices corresponding to highest

				arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.
20.1	Pratappur	Groundnut	Arrivals	Increasing trend.
			Prices	Increasing trend.
			Best Model	ARIMA(0,1,3)(1,0,1)[12] for arrivals and ARIMA(1,1,0)(1,0,1)[12] for prices have significant Ljung-Box test.
			Other Error measures	Lowest MAPE, MAE and MAPE.
			Highest Forecasted Arrivals	200.38 quintals in September, 2020 and 208.13 quintals in February, 2021.
			Correspond-ing Prices to Forecast	Rs. 5085.58/quintal in September, 2020 and Rs. 5066.62/quintal in February, 2021.
			Maximum Prices	Rs. 5089.44/quintal in February, 2020 and Rs. 5066.93/quintal in January, 2021.
			Conclusion	Forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a

				case is very beneficial to the farmers.

Best forecasts in terms of highest arrivals and highest prices for different crops in respective markets are concluded below:

S.N.	Oilseed crops	Parameter	Best Market	Month and Year
1.	Soybean	Arrivals	Mungeli	21332.96 quintals in November, 2020 and 21333.64 quintals in November, 2021.
		Prices	Rajnandgaon	Rs. 4027.78/quintal in January, 2020 and Rs. 4054.93/quintal in January, 2021.
2.	Groundnut	Arrivals	Patthalgaon	1308.00 quintals in November, 2020 and 1308.00 quintals in November, 2021.
		Prices	Pratappur	Rs. 5089.44/quintal in February, 2020 and Rs. 5066.93/quintal in January, 2021.
3.	Sesame	Arrivals	Ramanuj-ganj	447.53 quintals in November, 2020 and 372.29 quintals in November, 2021.
		Prices	Ambikapur	Rs. 7383.54/quintal in January, 2020 and Rs. 3513.08/quintal in April, 2021.

4.	Linseed	Arrivals	Rajnandgaon	457.17 quintals in June, 2020 and 476.34 quintals in June, 2021
		Prices	Rajnandgaon	Rs. 4440.20/quintal in January, 2020 and Rs. 4235.27/quintal in January, 2021.
5.	Mustard	Arrivals	Bhatapara	2161.92 quintals in May, 2020 and 1605.38 quintals in May, 2021.
		Prices	Bhatapara	Rs. 3482.23/quintal in May, 2020 and Rs. 3429.75/quintal in May, 2021.

Suggestions for Future Research:

- Forecasting of Arrivals And Prices of different Oilseeds crops could be done for agroclimatic zones by aggregating total arrivals and average prices of the constituent markets of respective agroclimatic zones of Chhattisgarh.
- Forecasting of Arrivals And Prices of different Horticultural crops could be done in Chhattisgarh.
- Forecasting of Arrivals And Prices of different millets could be done in Bastar Plateau since its cultivation is done there broadly.

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RESUME

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International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; SP-8(4): 82-85

Received: 07-05-2020
Accepted: 09-06-2020

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Forecasting the arrivals and prices of soybean in Chhattisgarh plains

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DOI: https://doi.org/ 10.22271/chemi.2020.v8.i4b.9867

Abstract
Under agricultural sector in India Oilseed crops have diverse area. In the State of Chhattisgarh, the oilseed crops, namely, groundnut, sunflower, niger, sesame, Soybean, linseed, mustard-rapeseed are grown in its different parts. Soybean occupies first position both in area and production among oilseeds in Chhattisgarh. It is grown mainly in Chhattisgarh Plains. For the development of agriculture it is quite necessary that farmers get good prices of their products in the agricultural markets. If there could be some forecast of arrivals and prices, the farmer would be benefitted in terms of selling its products. With the help of forecasting of arrivals and prices, farmers of this State could find the forecast for the specific month in which they get high and remunerative price of their produce. To get a good idea of the arrivals and prices of oilseeds varying over the time, it is necessary to study the time series patterns of arrivals and prices of Soybean over the years in Chhattisgarh Plains. Using the data collected in this study, different linear, non-linear and time series models are fitted for both variables in Chhattisgarh Plains, and best model based forecasts were made to fulfil the requirements of planners and farmers.

Keywords: Arrivals, prices, soybean, Chhattisgarh plains

Introduction
Oilseed crops play a very important role in the agricultural economy of India which has the distinction of large area under oilseed crops. The diverse agroecological conditions in the country are favourable for growing nine types of oilseeds. Out of these the seven edible oilseeds include the crops groundnut, rapeseed-mustard, Soybean, sunflower, sesame, safflower and niger seed while two non-edible oilseeds include the crops castor and linseed. Oilseeds occupy about 13% of gross cropped area and account for nearly 3% of gross national product (GNP) and 10% of the value of all agricultural commodities. In the State of Chhattisgarh, the seven oilseed crops, both edible and non-edible, namely, groundnut, sunflower, niger, sesame, Soybean, linseed, mustard-rapeseed are grown in its different parts. Soybean occupies first position both in area and production among all oilseeds in Chhattisgarh. The Soybean is one of the most important vegetable protein providing crops for millions of people across the world and is also ingredients for hundreds of chemical products.
For the development of agriculture it is quite necessary that farmers get good prices of their products in the agricultural markets. Therefore, the trends in market arrivals of commodities are useful in forecasting the arrivals and prices of the commodities for the betterment of farmers, governments, and agribusiness industries.
With the help of forecasting of arrivals and prices of Soybean, farmers of this State would find the forecast for the specific month in which they get high and remunerative price of his/her produce. This study aims at collecting the data of arrivals and prices of agricultural markets of Chhattisgarh Plains for Soybean, where data could be obtained. Using these data, different linear, non-linear and time series models have been fitted for Arrivals and Prices of Soybean in Chhattisgarh Plains, and best model based forecast has been attempted to fulfil the requirements of planners and farmers.

Materials and Methods
The time series data on the monthly arrivals and prices of Soybean have been collected from the records of the Agricultural Products Market Committees and the website of Chhattisgarh State Agricultural Marketing (*Mandi*) Board, http://agriportal.cg.nic.in/agrimandi/ or

http://cg.nic.in/agrimandi/. The data have been collected for the study period, i.e. 2010 to 2019 (10-years). For the study of arrivals and prices of Chhattisgarh Plains, the data for monthly arrivals and prices of Soybean have been obtained by summing up the monthly arrivals and averaging the monthly prices over different constituent markets for the period from 2010-2019. In the present study, Statistical analyses have been carried out using the powerful software "R: The Project for Statistical Computing".

Various time series forecasting models have been fitted to the arrivals and prices of the Soybean crop for the Chhattisgarh Plains, namely, polynomial models of suitable degree in time variable. Additionally, some non-linear models emanating from such transformation as Compound function, Inverse function, Logarithmic function, Power function, Exponential function, growth function, S-curve function, Exponential smoothing, apart from Holt-Winters, Autoregressive Integrated Moving Average (ARIMA) models have also been fitted. All the above-cited models were fitted using various functions available in the R software packages, like *lm()* function in the 'base' package, *HoltWinters()* in the 'stats' package, *arima()* in 'stats' package and 'forecast' package.

An autoregressive integrated moving average (ARIMA) is a generalization of an autoregressive moving average (ARMA). The autoregressive (AR) part of the ARIMA model indicates a type of random process representing certain time-varying processes in nature, economics, etc., while the moving average (MA) part is the average attained over a particular period of cycle.

This AR(p), an autoregressive model of order p, can be defined as,

$$Y_t = \mu + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \varepsilon_t \text{ ----------(3.2)}$$

where $\Phi_1, \ldots . \Phi_p$ are the parameters of the model, μ is a constant, and ε_t is white noise

The general MA process of order q can be defined as,

$$Y_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} \text{ ----------(3.3)}$$

where μ is the mean of series, the $\theta_1 \ldots \theta_q$ are the parameters of the model and the $\varepsilon_t, \varepsilon_{t-1}, \ldots, \varepsilon_{t-q}$ are the noise error terms.

Now, combining the AR process with the MA process and integrating, with differencing step, to remove non-stationarity from the non-seasonal time series, the ARIMA is generally denoted by ARIMA(p,d,q), where parameters p, d, and q are non-negative integers, where p is the order of the autoregressive model, d is the degree of differencing, and q is the order of the moving-average model. Thus, the ARIMA(p,d,q) model can be represented by the following general forecasting equation:

$$Y_t = \mu + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} + \varepsilon_t$$

For Arrivals and Prices of Soybean in Chhattisgarh Plains the best model will be that which have maximum R^2, minimum Mean Absolute Percentage Error (MAPE), minimum Mean Absolute Error (MAE), and minimum Root Mean Square Error (RMSE) criterion.

Results and Discussion

By fitting different linear and non-linear time series models, we got following results for arrivals of Soybean in Chhattisgarh Plains presented in the Table 1.

From the Table 1, although many linearized models have significant R^2 values, the ARIMA(1,0,1)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) and lowest AIC value (2953.5), as indicated above, among various models fitted apart from lowest error measures like RMSE (47227.7), MAE (32699.7) and MAPE (60.9). Thus, ARIMA model is chosen as best model for forecasting of Soybean arrivals in Chhattisgarh Plains.

Similarly, by fitting different linear and non-linear time series models as indicated above in Table 1, following results for prices of Soybean in Chhattisgarh Plains were obtained as presented in the Table 2.

From the Table 2, although many linearized models have significant R^2 values, the ARIMA(0,1,2)(1,0,1)[12] model has been found to be the best from various model-goodness-criteria points of views. It has significant Ljung-Box statistic (P-value <0.000) and lowest AIC value (1739.8), as indicated above, among various models fitted apart from lowest error measures like RMSE (344.6), MAE (249.1) and MAPE (10.5). Thus, ARIMA model is chosen as best model for forecasting of Soybean prices in Chhattisgarh Plains.

Table 1: Parameters of Fitted Model of Arrivals of Soybean in Chhattisgarh Plains

S.N.	Models	A	β_1	β_2	β_3	R^2 / Test-Statistics	P-Value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-8172493$^{\$}$	4100.9$^{\$}$	-	-	R^2=0.02$^{\$}$	P=0.076	72121.6	57913.5	239.6
	2nd order	-1.3x10^{10} **	1.1x10^{7} **	-2799.1**	-	R^2=0.10**	P=0.001	69438.4	54413.2	246.1
	3rd order	56353.1**	-6547.2^{NS}	7696.3^{NS}	-777.4*	R^2=0.14***	*P*<0.000	68338.3	50570.3	232.0
2.	Linearized Compound	-156.3*	0.08*	-	-	R^2=0.05*	P=0.011	78054.6	58399.3	155.8
3.	Linearized Inverse	1.2x10^{-68} $^{\$}$	-1.6x10^{10} $^{\$}$	-	-	R^2=0.02$^{\$}$	P=0.075	72117.4	57907.6	239.5
4.	Linearized Logarithmic	-6.2x10^{7} $^{\$}$	8.2x10^{6} $^{\$}$	-	-	R^2=0.02$^{\$}$	P=0.075	72119.5	57910.5	239.6
5.	Linearized Power	-	167.4*	-	-	R^2=0.05*	P=0.011	78051.8	58395.5	155.8
6.	Linearized Exponential	1.2x10^{-68} *	0.08*	-	-	R^2=0.05*	P=0.011	78054.6	58399.3	155.8
7.	Linearized Growth	-156.3*	0.08*	-	-	R^2=0.05*	P=0.011	78054.6	58399.3	155.8
8.	Linearized	178.4**	-3.3x10^{-5}	-	-	R^2=0.05*	P=0.011	78049.0	58391.6	155.8

	S-curve									
9.	Exponential Smoothing	0.54	-	-	-	χ^2=1.92	*P*<0.000	66044.0	45987.0	75.4
10.	ARIMA (1,0,1)(2,0,0)[12]	-	-	-	-	χ^2=0.01	*P*<0.000 AIC=2953.5	47227.7	32699.7	60.9
Note: - Polynomial models upto 3rd order are significant.										
Notations:-										
*	Significant at 5% level of Significance									
**	Significant at 1% level of Significance									
***	Significant at 0.1% level of Significance									
$	Significant at 10% level of Significance									

Table 2: Parameters of Fitted Model of Prices of Soybean in Chhattisgarh Plains

S.N.	Models	α	β_1	β_2	β_3	R^2/Test-Statistics	P-Value / AIC	RMSE	MAE	MAPE
1.	Linearized Polynomial 1st order	-192789.3***	96.83***	-	-	R^2=0.20***	*P*<0.000	546.3	433.0	21.5
	2nd order	-9.0x10^7 ***	89626.3***	-22.2***	-	R^2=0.27***	*P*<0.000	523.6	431.5	20.3
	3rd order	1066.81***	1240.9***	-298.7***	20.4***	R^2=0.62***	*P*<0.000	377.6	277.6	12.0
2.	Linearized Compound	2.6x10^{-45} ***	1.05***	-	-	R^2=0.27***	*P*<0.000	561.6	445.9	20.7
3.	Linearized Inverse	197502***	-3.9x10^8 ***	-	-	R^2=0.20***	*P*<0.000	546.1	433.0	21.5
4.	Linearized Logarithmic	-1.4x10^6 ***	1.9x10^5 ***	-	-	R^2=0.20***	*P*<0.000	546.2	433.0	21.5
5.	Linearized Power	-	110.3***	-	-	R^2=0.27***	*P*<0.000	561.5	445.9	20.7
6.	Linearized Exponential	2.6x10^{-45} ***	0.05***	-	-	R^2=0.27***	*P*<0.000	561.6	445.9	20.7
7.	Linearized Growth	-102.6***	0.05***	-	-	R^2=0.27***	*P*<0.000	561.6	445.9	20.7
8.	Linearized S-curve	118.1***	-2.2x10^5 ***	-	-	R^2=0.27***	*P*<0.000	561.5	445.9	20.7
9.	Exponential Smoothing	0.55	-	-	-	χ^2=0.90	*P*<0.000	358.3	262.2	11.0
10.	ARIMA (0,1,2)(1,0,1)[12]	-	-	-	-	χ^2=0.007	*P*<0.000 AIC=1739.8	344.6	249.1	10.5
Note: - Polynomial models upto 3rd order are significant.										
Notations:-										
*	Significant at 5% level of Significance									
**	Significant at 1% level of Significance									
***	Significant at 0.1% level of Significance									
$	Significant at 10% level of Significance									

After identification of the model, forecasting of arrivals and prices of Soybean has been done. The best ARIMA model has been used to forecast the arrivals and prices of Soybean in Chhattisgarh Plains for the period of Jan 2020 to Dec 2021 and the results so obtained are presented in the Table 3 and also depitcted in graph in Fig. 1 and Fig. 2.

Table 3: Forecasted values of arrivals and prices of Soybean in Kawardha market

Months	Predicted Arrivals (quintals)		Predicted Prices (Rs./quintal)	
	2020	2021	2020	2021
January	81529.35	87655.07	3294.98	3191.81
February	80507.95	85439.18	3162.55	3184.89
March	85209.04	89144.56	3060.53	3144.61
April	68336.20	71608.58	3047.17	3139.33
May	66702.03	69363.13	3167.61	3186.89
June	67038.09	69197.42	3124.53	3169.88
July	57578.90	59399.58	3110.11	3164.19
August	48027.20	49588.86	3109.17	3163.81
September	38240.76	39608.40	3080.52	3152.50
October	136175.62	136688.17	3130.72	3172.32
November	190583.12	190569.23	3136.59	3174.64
December	101487.87	101928.90	3216.29	3206.11

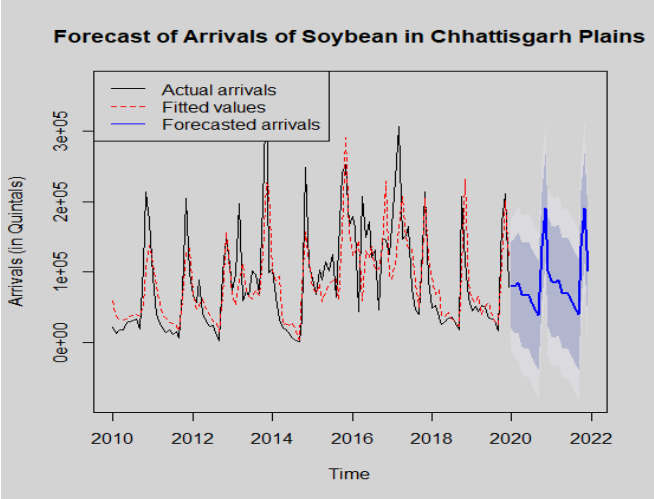

Fig 1: Forecasts of Arrivals of Soybean in Chhattisgarh Plains

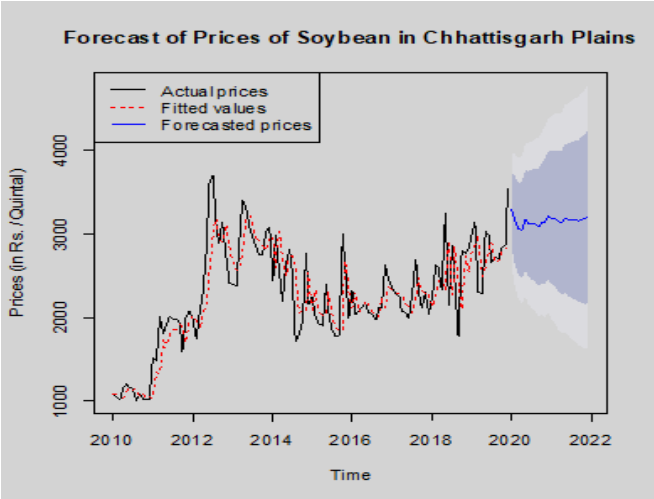

Fig 2: Forecasts of Prices of Soybean in Chhattisgarh Plains

From the Table 3, the highest forecasted arrivals of Soybean for Chhattisgarh Plains are expected to be 190583.12 quintals and 190569.23 quintals respectively in the months of November, 2020 and November, 2021 with respective for casted prices to be Rs. 3136.59/quintal and Rs. 3174.64/quintal. However, the maximum prices were found to be Rs.3294.98/quintal in the month of January, 2020 and Rs. 3206.11/quintal in the month of December, 2021.

Conclusion

Among the different models fitted, the model ARIMA(1,0,1)(1,0,1)[12] for arrivals and the model ARIMA(0,1,2)(1,0,1)[12] for prices have been found to be the best to forecasting the arrivals and prices of Soybean in Chhattisgarh Plains from various model-goodness-criteria points of views. Both variables have significant Ljung-Box statistic (P-value <0.000 for both arrivals and prices) and lowest AIC values (2993.5 for arrivals and 1739.5 for prices), among various models fitted, apart from lowest error measures like RMSE, MAE and MAPE, the values not being given here for brevity. In the study period, it was observed that the forecasted prices corresponding to highest arrival are very close to maximum prices within a close variation of months. Such a case is very beneficial to the farmers.

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