Open Access

© 2023, Centre for Advanced Research in Agricultural Sciences
Research Journal of Agricultural Sciences
Volume 14; Issue 01; pp 105–109

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Full Length Research Article

Price Behavior and Forecasting of Soybean Prices in Bidar and Dharwad Markets of Karnataka State

Murulidhar M. Venkannanavara*[1] and N. M. Kerur[2]

[1] Faculty (Agribusiness and Food processing), School of Agribusiness and Rural Management, Karnataka State Rural Development and Panchayat Raj University, Gadag, Karnataka, India

[2] Professor (Agribusiness Management), College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

Abstract

The present study mainly focused to analyze the behavior of Soybean prices in Bidar and Dharwad markets in Karnataka and forecasting the prices for the future. Based on secondary data from January 2005 to October 2022, the future prices were predicted for the next six months, by employing the Auto Regressive Integrated Moving Average (ARIMA) technique. The annual increase in price trend of Soybean in Bidar and Dharwad markets were observed to be Rs 288.0 and 388.0 per quintal per annum. The highest seasonal indices of prices were observed in the month of February (106.1), May (109.3) in Bidar and Dharwad markets respectively. Highest indices of arrivals were found in November (381.0) in Bidar, (175.5) in Dharwad market. Maximum R-Square (0.92), (0.91), minimum Mean Absolute Percentage Error (MAPE) (8.563), (9.902), Root Mean Square Error (RMSE) (290.65), (313.59), Mean Absolute Error (MAE) (196.21), (209.24) and Normalized BIC (11.45) and (11.550) respectively in Bidar and Dharwad markets, were used as a criteria to select the best model for price forecasting. Based on the above criteria the model (1,1,2) (0,0,0) and (0,1,2) (1,0,1) were found to fit the time series to predict future prices. The forecasted price of soybean would be ranging from Rs 4678 to 6301 and Rs 5028 to 6535 per quintal during the cram months in Bidar and Dharwad markets respectively.

Key words: Trend, Seasonal indices, ARIMA technique, Price forecasting, Normalized BIC

Soybean is an important oil seed crop in India as well as in the world. With the introduction and inception of commercial cultivation in India in late 60's, the crop is being cultivated in around 11.8 million hectares with production of 13.5 million ton (2020-21). In a very short period of time, the crop was adopted by farmers as major kharif crop in MP and afterwards the acreage increased in Maharashtra, Rajasthan, Northern Karnataka, Gujarat and Northern Telangana. Presently soybean is contributing 42 per cent share of total oil seed and 22 per cent to total oil production in the country. With increase in population the demand of edible oil is increasing and 40% of the demand is being fulfilled by different oil seed crops and rest 60% demand is being made up by import. The cost of import of edible oil put a high pressure on our foreign exchange. Among all the oil seed crops, soybean is having the highest potential to meet the challenge of being self-sufficient in production of edible oil.

Soybean price fluctuations are occurring all over Indian markets and they are causing smash up to both soybean producers and consumers. The ARIMA model is commonly used in time series analysis prediction of prices, especially for series that has a cyclic or seasonal pattern. At the same time, Box-Jenkins ARIMA model give the good representation of short time forecasting. The principle of the model contains filtering out the high-frequency noise in the data, detecting local trends based on liner dependence and forecasting the trends. Despite its high predictive performance, the model has some limitations which decrease its scope of application. The model assumes a linear relationship between the dependent and independent variables while the actual data often present non-linear relationships. Besides, the model assumes that the mean and variance of response series are independent of time, which means stationary. Thus, more than one model should be tested to choose a better one. Forecasting of prices of perishable agricultural commodities is very difficult because they are not only governed by demand and supply but also by so many other factors which are beyond control like weather vagaries, storage capacity, transportation etc. Chahal *et al.* [1] examined the price behaviour of green peas in Hoshiarpur and Ludhiana (Punjab) markets from 1994 to 2002. Sangeeta [2] analyzed the behaviour of arrivals and prices of onion in Lasalgaon and Pune markets (Maharashtra) from 1999-2002. Devi *et al.* [3] studied

Received: 14 Oct 2022; Revised accepted: 30 Dec 2022; Published online: 14 Jan 2023

Correspondence to: Murulidhar M. Venkannanavara, Faculty (Agribusiness and Food processing), School of Agribusiness and Rural Management, Karnataka State Rural Development and Panchayat Raj University, Gadag, Karnataka, India, Tel: +91 9535195695; E-mail: murulidharmv@gmail.com

Citation: Venkannanavara MM, Kerur NM. 2023 Price behavior and forecasting of soybean prices in Bidar and Dharwad markets of Karnataka State. *Res. Jr. Agril Sci*. 14(1): 105-109.

the price behaviour of chillies in Guntur market of Andhra Pradesh, India for the years 1997-2014. ARIMA model was employed by Darekar *et al.* [4] to forecast the prices of onion at Lasalgaon market of Western Maharashtra. The main objective of present research was to analyze the price behaviour and forecasting of soybean prices in Bidar and Dharwad markets of Karnataka state.

MATERIALS AND METHODS

The time series data on monthly prices of soybean required for the study, was collected from the registers maintained by the respective market APMCs, Krushimaratavahini, Agmarknet. The data related to monthly modal prices (Rs/qtl) for the period from January 2005 to October 2022 was used for time series analysis and for price forecasting from December 2022 April 2023. To analyze all the four components of a time series viz., trend, seasonal, cyclical and irregular fluctuations, a multiplicative model of the following type was used as elucidated in Areef *et al.* [5]:

$$\text{Monthly data } Yt = Tt \times St \times Ct \times It$$

where,
Yt = Time series data on prices at time period 't'
Tt = Trend component at time period 't'
St = Seasonal variations at time period 't'
Ct = Cyclical movements at time period 't'
It= Irregular fluctuations at time period 't'

Trend component

Over a long period, time series is likely to show tendency to either increase or decrease over time. Price trend explains the general direction of the movement of prices over long period of time. Ordinary least square method was employed to ascertain the trend in prices by estimating the intercept (a) and slope coefficient (b) in the following linear functional form:

$$Yt = a + bXt + et$$

where,
Yt = Trend value at time t
Xt = period (Serial number assigned to the t^{th} month)
et = Random disturbance term (assumption of zero mean and constant variance)
a = Intercept parameter
b = Slope parameter

The goodness of fit of trend line to the data was tested by computing the multiple coefficient of determination (R^2).

Seasonal variations

In order to estimate the seasonal variation, the twelve-month centered moving average method was used which gives us the periodic changes without seasonality. To estimate the seasonal index, a 12-month centered moving average was calculated as follows:

$M1 = Y1 + Y2 + Y3 + \ldots + Y12 / 12$
$M2 = Y2 + Y3 + Y4 + \ldots + Y13 / 12$
$M3 = Y3 + Y4 + Y5 + \ldots + Y14 / 12$ ………etc.

This is sequential manner for each point of time t. In this fashion, a 12-month centered moving average removes a large part of fluctuation due to the seasonal effects so that what remains is mainly attributable to other sources viz., long term effects Tt, cyclical effect Ct and the irregular variation It which is due to random causes is also minimized by the process of smoothing out effect.

$$St = Y/(TC)t = Tt^* Ct^* St^* It / Tt^* Ct$$

It is always expressed in terms of percentages. In this process, we do not have moving average for the first six and last six months. These seasonal components are next arranged month-wise for each year. The last row in the study gives estimates of seasonal index for the 12 months adjusted for their total to 1200 or averaged to 100.

$$(TCI)t = Yt / St = (TCSI)t / St$$

Cyclical movements

Cyclical variations are long term oscillatory movements with duration of greater than one year. The most commonly used method for estimating cyclical movement of time series is the residual method by eliminating the seasonal variation and trend. This is accomplished by dividing (Yt) by corresponding (S) for time 't'
Symbolically,

$$T.C.S.I/S \text{ and } T.C.I/T = C.I$$

Auto regressive integrated moving average

Introduced by Box and Jenkins [6], the ARIMA model has been one of the most popular approaches for forecasting. The ARIMA model is basically a data-oriented approach that is adopted from the structure of the data itself. In an ARIMA model, the estimated value of a variable is supposed to be a linear combination of the past values and the past errors. Generally a time series can be modelled as a combination of past values and errors, which can be denoted as ARIMA (p,d,q) which is expressed in the following form:

$$Yt = \theta 0 + \Phi 1 Yt\text{-}1 + \Phi 2\, Yt\text{-}2 + \ldots + \Phi p\, Yt\text{-}p + et - \theta 1 et\text{-}1 - \theta 2\, et\text{-}2 - \theta\, et\text{-}q$$

Where, Yt and et are the actual values and random error at time t, respectively, Φi (i = 1,2, ……., p) and θj (j = 1,2, ……, q) are model parameters, p and q are integers and often referred to as orders of autoregressive and moving average polynomials respectively. Random errors are assumed to be independently and identically distributed with mean zero and constant variance. Similarly, a seasonal model is represented by ARIMA (p, d, q) × (P, D, Q), where P is the number of seasonal autoregressive (SAR) terms, D is the number of seasonal differences and Q is the number of seasonal moving average (SMA) terms. Basically this method has four steps identification of the model, estimating the parameters, diagnostic checking and forecasting.

RESULTS AND DISCUSSION

The results revealed from the (Fig 1-4), that there was an increased trends in prices of soybean in Bidar market (Y = 512 + 288t) and Dharwad markets (Y = 639 + 388t) of Karnataka, On the other hand, revealed that there is a positive slope in arrivals in Bidar (Y = 8791 + 2027t) and Dharwad market (Y = 989 + 214t) of Karnataka, two markets in each of the chosen in state for soybean crop were subjected for in depth analysis. Linear trend analysis for price of soybean indicated a positive trend in the selected markets. The prices of soybean did increase in the selected markets, but the extent of increase in prices varied from market to market.

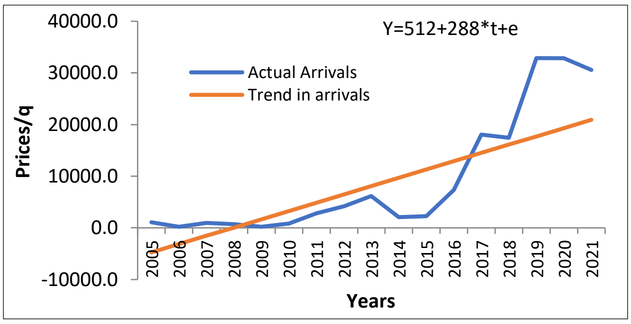

Fig 1 Trends in prices of soybean in Bidar market

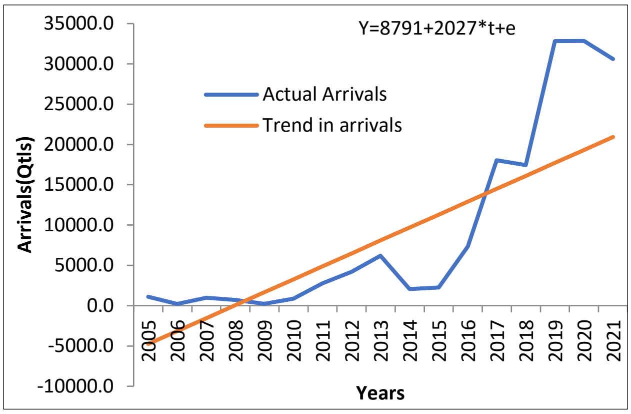

Fig 2 Trends in arrivals of soybean in Bidar market

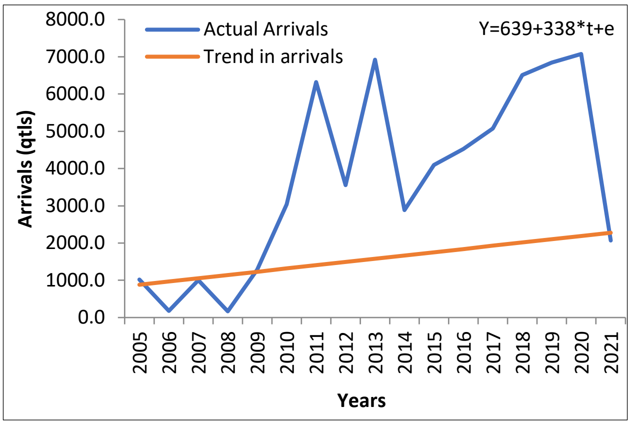

Fig 3 Trends in prices of soybean in Dharwad market

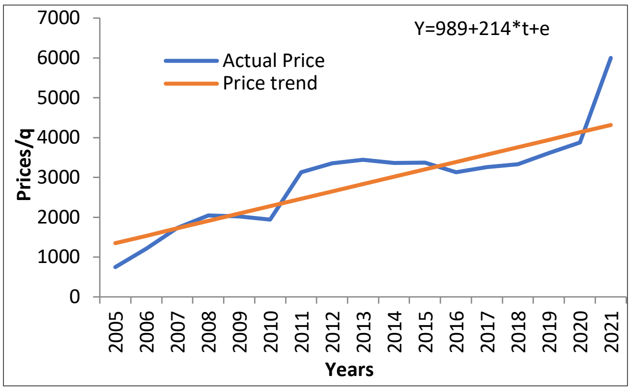

Fig 4 Trends in arrivals of soybean in Dharwad market

It could be observed from (Table 1) that the prices in the selected markets showed increasing trend. Dharwad market (Rs. 388/qtl) registered the highest increasing trend in prices of soybean. Over the years where the annual increment in prices was at the rate of Rs. 288 to Rs. 388 per quintal in Bidar and Dharwad market respectively, the annual increment in arrivals was found to be the incremental in Bidar market (Rs. 2027/qtl).

It could be observed from the results presented in (Table 2). that soybean price indices in selected markets of Karnataka were higher in January, February, March, April (ranging from 104.1 to 102.1) in Bidar market, whereas in Dharwad market indices were higher during April to August months (ranging from108.3 to 101.2). The same is represented graphically in (Fig 5). The indices for soybean arrival presented in the table indicated higher indices in the months of November (381) for Bidar market and Feb. (175.5) in Dharwad market of Karnataka.

Table 1 Trends in prices and arrivals of soybean in selected markets in India during study period

States	Markets	Prices (Rs)	R^2	Arrivals (q)	R^2
Karnataka	Bidar	Y = 512+288**t	0.67	Y = 8791+ 2027**t	0.71
	Dharwad	Y = 639+388**t	0.79	Y = 989 +214**t	0.58

**Significant at 1 per cent level

Table 2 Seasonal indices for soybean in selected markets of India during study period (Prices in, Arrivals in qtls)

States	Karnataka			
Markets	Bidar		Dharwad	
Months	Prices	Arrivals	Prices	Arrivals
January	104.1	105.0	99.2	85.3
February	106.1	35.7	97.7	129.4
March	105.4	16.7	94.7	146.2
April	102.1	19.8	108.3	175.5
May	100.6	9.5	109.3	120.5
June	100.5	15.8	105.7	69.5
July	100.1	9.4	102.2	68.5
August	97.4	9.5	101.2	93.8
September	96.0	32.9	96.9	75.0
October	89.7	351.5	93.3	87.8
November	96.2	381.0	95.1	54.8
December	101.9	213.2	96.5	93.6

Results revealed that the seasonal variations were observed in prices of soybean in all the selected markets. When the arrivals of soybean to the market were high, the prices were found to be high in both the markets but in different periodic months, However, in Bidar market, higher seasonal indices were found during the months of December to January with similar trend in indices of arrivals and prices, same thing notices in Dharwad market during April and may months. This positive correlation between arrivals and price trend may be attributed to the fact that farmers are well aware of trend in market prices and commodity comes to these markets in anticipation of higher prices due to higher number of buyers and exhibition of perfect competition among buyers in the markets. The same pattern of positive correlation in Bidar and Dharwad market between arrivals and price of soybean, but during different months was due to fact of cultivation of soybean during differential seasonal aspects (Kharif /Rabi) and also arrivals from Maharashtra and Telangana. The variation in prices (as indicated by seasonal indices) may be due to the nature of production of soybean, availability of storage facilities and processing facilities. The reason of immediate cash requirement by the farmers also compelled them to go for sale immediately after harvest [7].

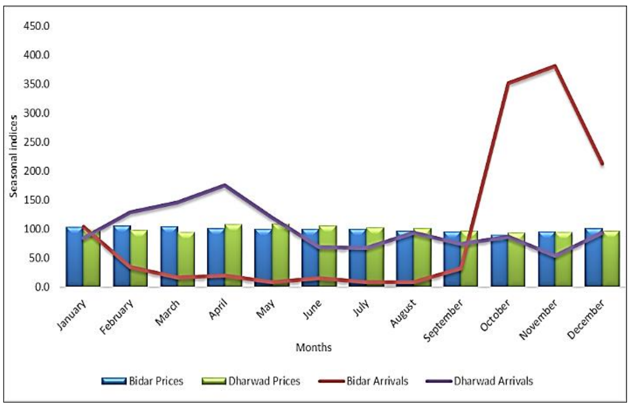

Fig 5 Seasonal variations in arrivals and prices of soybean in Bidar and Dharwad markets

Table 3 ARIMA model to the prices of soybean in selected markets

Markets	Fitted models	R^2	RMSE	MAPE	MAE	MaxAPE	MaxAE	Normalized BIC
Bidar	(1.1.2) (0,0,0)	0.924	290.658	8.563	196.244	128.435	1497.403	11.452
Dharwad	(0.1.2) (1,0,1)	0.914	313.591	9.902	209.242	204.242	1225.011	11.550

R^2 – Coefficient of determination
RMSE – Root Mean Square Error
MAPE – Mean Absolute Percentage Error
MAE – Mean Absolute Error
MaxAPE – Maximum Absolute Percentage Error
MaxAE – Maximum Absolute Error
BIC - Bayesian Information Criterion

Table 4 Price forecast for soybean in Bidar and Dharwad markets of Karnataka

Markets	Bidar					Dharwad				
Month and years	Actual price	Forecasted price	LCL	UCL	Deviation	Actual price	Forecasted price	LCL	UCL	Deviation
Jun-21	6434	6301	5657	6944	132	6601	6535	5903	7168	65
Jul-21	7467	6465	5821	7109	1001	7150	6595	5962	7227	555
Aug-21	8357	7508	6865	8152	848	7239	7080	6447	7712	159
Sep-21	6410	8066	7422	8709	-1656	6730	7064	6432	7697	-334
Oct-21	4844	6091	5447	6735	-1247	6273	6565	5932	7197	-292
Nov-21	5627	4937	4293	5581	689	5636	6340	5707	6972	-704
Dec-21	6131	5735	5092	6379	395	6180	5785	5152	6417	394
Jun-22	6053	6198	5554	6841	-145	6164	6245	5612	6877	-81
Jan-22	6422	6127	5483	6770	295	6259	6061	5429	6694	197
Feb-22	7142	6521	5877	7164	620	5732	6313	5680	6946	-581
Mar-22	7202	7257	6613	7900	-55	7052	6366	5734	6999	685
Apr-22	6714	7199	6555	7843	-485	6693	6837	6205	7470	-144
May-22	6277	6694	6050	7338	-417	6005	6479	5847	7112	-474
Jun-22	6112	6309	5665	6952	-197	6333	6181	5549	6814	151
Jul-22	5971	6154	5511	6798	-183	5700	6264	5631	6896	-564
Aug-22	5031	5681	5037	6324	-650	5400	5566	4934	6199	-166
Sep-22	4476	4711	4068	5355	-235	4872	5213	4580	5845	-341
Oct-22	6434	4568	3924	5212	132	6601	4874	4242	5507	65
Nov-22		4678	3768	5587			5094	4275	5913	
Dec-22		4745	3631	5859			5144	4174	6115	
Jan-23		4819	3532	6105			5077	3976	6178	
Feb-23		4918	3480	6357			5028	3811	6246	
Mar-23		5034	3459	6609			5785	4461	7109	
Apr-23		6301	5657	6944			6535	5903	7168	

LCL- Lower Critical Limit: UCL- Upper Critical Limit

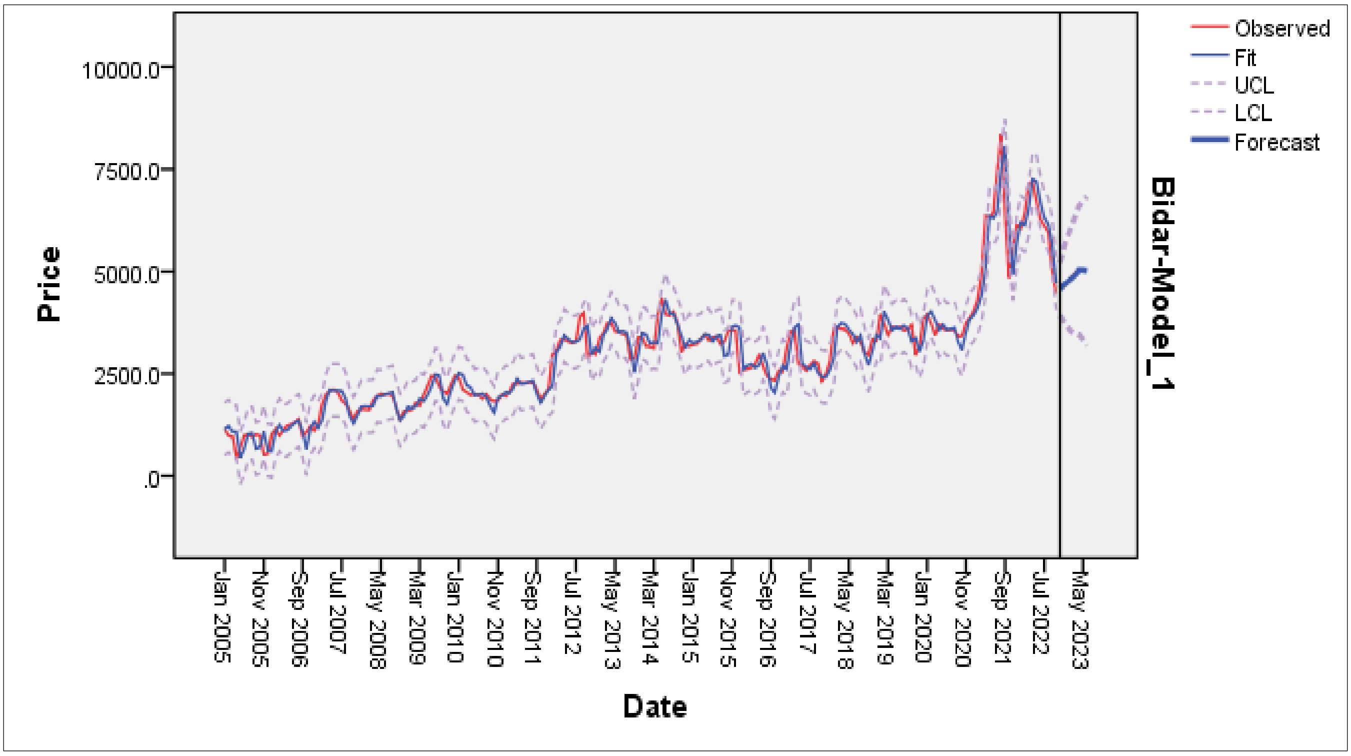

Fig 6 Price forecast of soybean from Bidar market

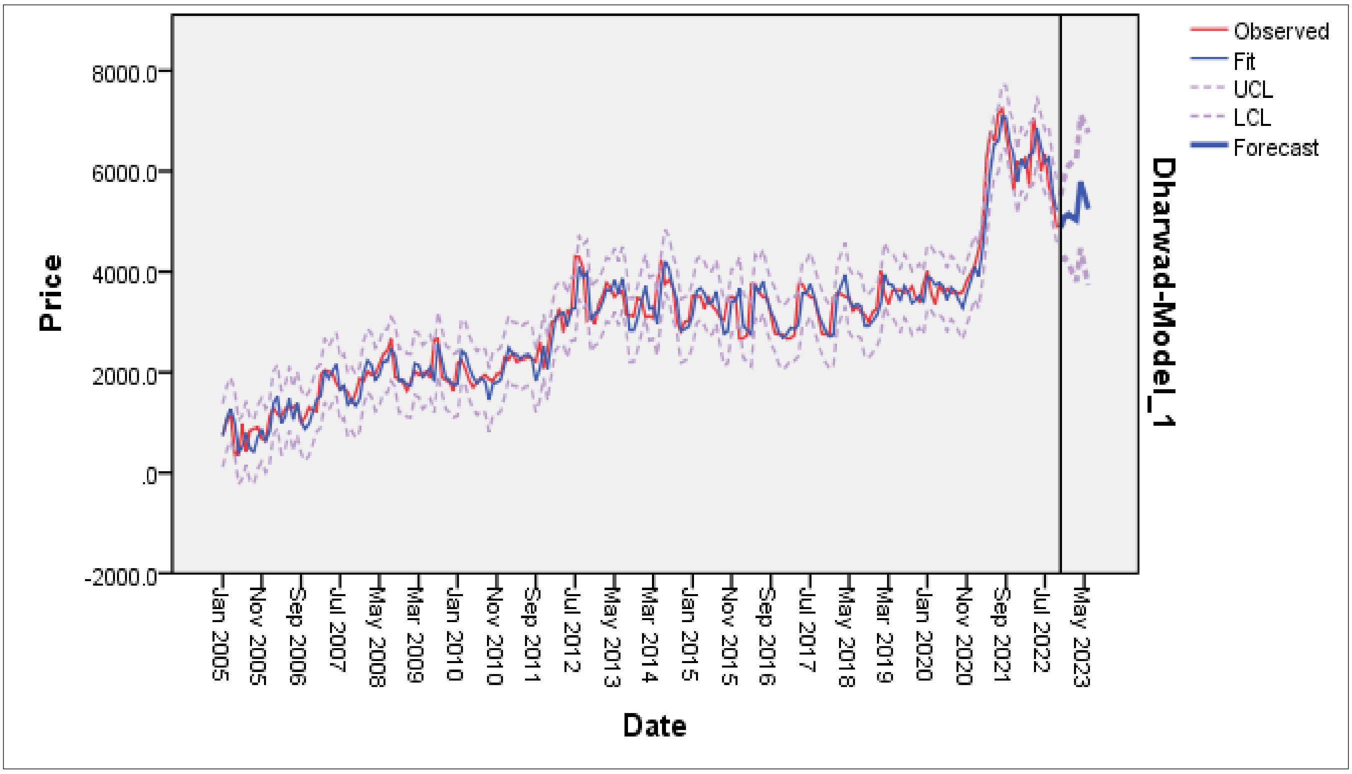

Fig 7 Price forecast of soybean from Dharwad market

From the different (p, d, q) models, ARIMA model was selected based on the lowest MAPE and normalized BIC values for forecasting the prices of the soybean under study in different markets of Karnataka. The suitability of the forecasting model was judged based on the MAPE values, these values for soybean in market of Bidar and Dharwad, were 8.563, 9.902, with their respective normalized BIC values of 11.452, 11.550. The model parameters were estimated using SPSS software and the best fitted models were used for forecasting. The results were presented from (Table 3). The forecasted prices of soybean in Bidar showed increasing trend initially (Fig 7), while Dharwad market (Fig 8) showed fluctuating trend [8].

In the present investigation a large-scale comparison was done in order to know the best model for forecasting of prices of Soybean. The models were fitted based on the MAPE and Normalized BIC values which were considered to be least. The ARIMA model for soybean in Bidar, Dharwad, showed the least MAPE values of 8.563, 9.902, respectively and corresponding BIC values of 11.452, 11.550, were considered to be best among fit.

The forecast has been done for the prices of soybean using ARIMA model for Bidar and Dharwad markets of Karnataka up to April 2023 (Table 4). Hence, farmers can take benefit of this by planning their production and sale of the produce during the months of high prices use of place utility for better realization of prices [9].

CONCLUSION

Soybean is an important crop cultivated in Karnataka, for the benefit of farmers, reliable price forecast model enable the government to make appropriate decisions in advance like procurement, regulating export & imports and possibility of check on trader hoardings. The price seasonal indices and forecasted price information was more important for the farmer to selection of crop varieties, allocation of scarce inputs under different crops and adjusting the sowing & harvesting dates to get remunerative prices in a more rational way.

LITERATURE CITED

1. Chahal SS, Singla R, Kataria P. 2004. Marketing efficiency and price behaviour of green peas in Punjab. *Indian Journal of Agricultural Marketing* 18: 115-128.
2. Sangeeta S. 2004. Marketing of onion in Maharashtra. *Indian Journal of Agricultural Marketing* 4: 45-50.
3. Devi IB, Srikala M, Ananda T. 2016. Price behaviour of chillies in Guntur market of Andhra Pradesh, India. *Indian Journal of Agricultural Research* 50: 471-474.
4. Darekar AS, Pokharkar VG, Yadav DB. 2016. Onion price forecasting in Yeola market of Western Maharashtra using ARIMA technique. *International Journal of Advanced Biological Research* 6: 551-552.
5. Areef M, Rajeswari S, Vani N, Naidu GM. 2019. A study on price behaviour of onion in Bangalore market of Karnataka, India. *The Andhra Agricultural Journal* 66: 37-41.
6. Box GEP, Jenkins GM. 1976. *Time Series Analysis: Forecasting and Control*. Holden-Day, San Francisco.
7. Tingre AS, Bhopale AA, Deshmukh RG.2016. Price stability of soybean for major markets of India. *International Research Journal of Agricultural Economics and Statistics* 7(2): 169-174.
8. Megha M, Singh K, Kanakaraj A. 2009. Market integration, transaction costs and the Indian wheat market: A systematic study. *Econ. and Polit. Weekly* 44(22): 149-155.
9. Gosh M. 2011. Agricultural policy reforms and spatial integration of food grain markets in India. *Jr. Econ. Develop*. 36(2): 15-36.