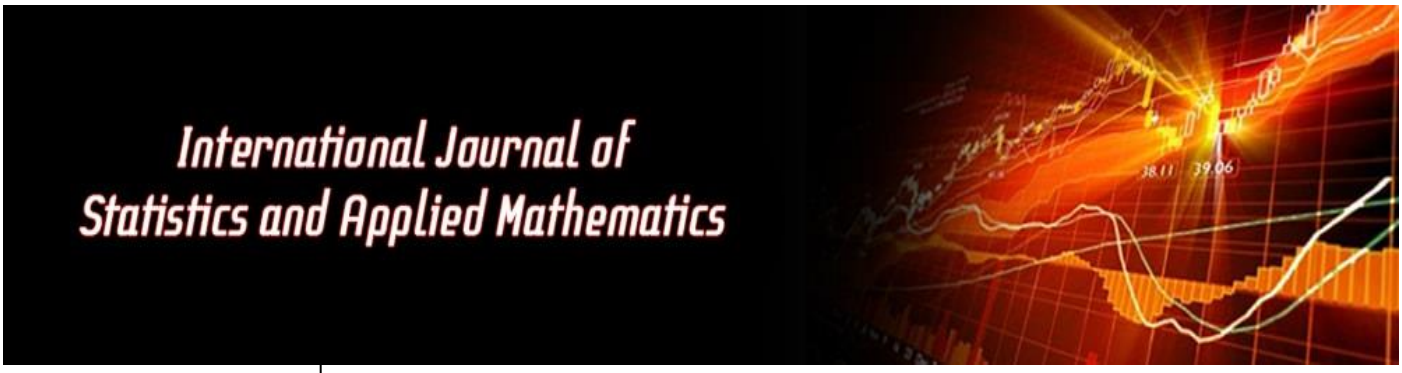

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Forecasting cotton prices in major domestic markets of India: An analytical approach

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Abstract
Cotton is one of the most important fibre crops playing essential role in the history of mankind and civilization. India is the largest producer of cotton followed by China. High volatility in prices of agricultural commodities over the time generate the need for the accurate price forecasting for policy makers for effective planning and monitoring. For the present study, monthly time series data on cotton prices in six major national markets were collected from January, 2001 to December, 2021. ARIMA and SARIMA model was employed to predict the future prices of cotton using the SPSS software. By comparison of forecast performance *i.e.,* Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), best fit model was used for prediction of future cotton prices. Results of cross validation of each fitted model was compared and model with lesser percentage of absolute error margin was selected as best fit model. On the basis of comparison, SARIMA model was used to predict cotton prices in Adoni and Sendhwa market, whereas in Parbhani, Budalada, Rajkot and Gondal market, ARIMA model was found better for forecast. Results of price forecasting revealed that in Parbhani, Budalada, Sendhwa and Rajkot markets, the predicted values were found higher in November with Rs. 9380.47/qtl, Rs. 8440.35/qtl, Rs. 8809.70/qtl and Rs. 8927/qtl, respectively. Moreover, in Gondal market, the predicted prices were found higher in month of December.

Keywords: Cotton**,** price forecasting, ARIMA, SARIMA, future prices

Introduction
Cotton is generally regarded as 'King of Fibers', which has made significant contribution to the Indian economy. The Indian economy gets influenced by cotton through its export performances, textile industry and processing sectors by generating direct or indirect employment for millions of people. India is the largest producer of cotton followed by China, United States, Brazil, *etc*. Maharashtra is the leading producer of cotton with 27 per cent of the total output of India followed by Gujarat (19%) and Telangana (16%) (DES, 2022) [4].
High volatility in prices of agricultural commodities over the time generate the need for the accurate price forecasting for policy makers for effective planning and monitoring. The nature and extent of price fluctuations provides necessary guidance to farmers for marketing the products efficiently. Forecasting act as a warning signal and favors the policymakers to attain an insight about the future prices (Muhammad, 2017) [7]. The time series approach to forecasting is one such approach which relies on the past pattern in a time series to forecast prices in the future. (Darekar & Reddy, 2017) [2-3].

Data collection and Methodology
The research was carried out using the secondary data from various sources. The monthly time series data of cotton prices of selected markets were collected from January, 2001 to December, 2021 for this analysis. The price series was deflated to form real price trends. In the case of domestic cotton market prices, the series was deflated by wholesale price index. Six domestic cotton markets *viz*., Gondal (Gujarat), Rajkot (Gujarat), Parbhani (Maharashtra), Adoni (Andhra Pradesh), Budalada (Punjab) and Sendhwa (Madhya Pradesh) were selected for the present study on the basis of volume of transactions, experts' opinion and availability of continuous data.

ARIMA model

An autoregressive integrated moving average (ARIMA) model is characterized by the notation ARIMA (p, d, q) where p, d and q denotes orders of auto-regression, integration (differencing) and moving average, respectively. ARIMA is a parsimonious approach, which can represent both stationary and non-stationary process. An ARMA (p, q) process is defined by the equation

$$P_{1t} = \mu + \phi_1 P_{1t-1} + \phi_2 P_{1t-2} + \cdots + \phi_p P_{1t-p} + \theta_0 \varepsilon_{1t} + \theta_1 \varepsilon_{1t-1} + \cdots + \theta_q \varepsilon_{1t-q} \quad (1)$$

Where,

P_{1t} = price of series at time period *t*

μ = constant term.

ϕ_i (i = 1,2,...,p) and θ_1 (j=0,l,2,...,q) are model parameters.

ε_{1t} = Random Error at time period t.

ε_{1t} ~ IID (0, σ^2)

However, in practical applications, residuals obtained after fitting of appropriate ARIMA model may have non-constant error variance. Engle (1982) [5] proposed to model time-varying conditional variance with auto-regressive conditional heteroscedasticity (ARCH) process using lagged disturbance.

SARIMA Model

The SARIMA methodology is a multiplicative model that is widely used by statisticians for analyzing time series data. It was invented by Box and Jenkins in 1976 [1]. It is preferred because of its high degree of accuracy. When the data to be analyzed is seasonal, the SARIMA is used.

The Seasonal ARIMA model (SARIMA) is formed by adding seasonal terms in the ARIMA models:

SARIMA (p, d, q) (P, D, Q) (2)

Where p is a non-seasonal autoregressive order, P is a seasonal autoregressive order, q is a non-seasonal moving average order, Q is a seasonal autoregressive order, d and D are the order of common difference and seasonal difference.

(1 - ϕ1 BƆ – ϕ2 B2Ɔ - ... – ϕp BPƆ) × (1 – φ1 B – φ2 B2 - … - φp Bp) × (1 -BƆ)D (1 – B)d Qn (t) = (1 - Θ1 BƆ – Θ2 B2Ɔ - ... – Θ1Q BQƆ) × (1 - Θ1 B – Θ2 B2 - ... – Θq Bq) e(t), (3)

ϕ is the non-seasonal parameter of autoregression and θ is the non- seasonal parameter of moving average, Q is the seasonal parameter of autoregression and Θ is the seasonal parameter of moving average, ω is frequency and B is the differential variable.

Results and Discussion

Fitting of ARIMA model to selected cotton markets

To build ARIMA model, the preliminary step is to identify the parameter of the model and then estimation is done by least square method or conditional or exact- likelihood method. At last diagnostic checking is done. Forecasting through ARIMA model was performed using SPSS software package.

To apply standard stationary inference problems in dynamic time series models, variables under consideration should be stationary. ARIMA model could not be built until the input data series is made stationary. Results of Augmented Dickey-Fuller test, indicated that all the market price series were stationary at their first differences. Identification of the model was concerned with deciding the appropriate values of (p,d,q). It was done by observing Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) values. The ACF helps in choosing the appropriate values for ordering of moving average terms (MA) PACF for those autoregressive terms (AR).

Selecting the candidate model for forecasting

The following expected ARIMA models as furnished in Table 1. ARIMA (4, 1, 3) for both Adoni and Parbhani market, ARIMA (4, 1, 2) for Budalada and Rajkot market, ARIMA (13, 1, 8) for Sendhwa market and ARIMA (3,1,1) for Gondal market were selected on the basis of the highest values of adjusted R^2 and the lowest values of Mean Absolute Percentage Error (MAPE).

Also, Ljung box test results were also given in Table 1. The Ljung- Box (LB) test was used to check autocorrelation among the residuals. The overall fitness of the selected model for forecasting can be understood only when the residuals are not autocorrelated. Q stat values showed that the residuals are normally and independently distributed in all the selected markets, except in Sendhwa market which shows the inadequacy of chosen ARIMA model.

Table 1: Summary of the selected ARIMA models for forecasting monthly cotton prices in selected cotton markets

SL. NO.	Market	Market Selection Criteria					Selected ARIMA model
		Adj- R^2	MAPE	MAE	BIC	RMSE	
1	Adoni (Andhra Pradesh)	0.95	6.08	208.14	11.74	324.28	ARIMA(4, 1, 3)
							Q-stat: 8.241 (0.692)
2	Parbhani (Maharashtra)	0.91	5.97	237.82	12.33	434.98	ARIMA(4, 1, 3)
							Q-stat: 11.726 (0.385)
3	Budalada (Punjab)	0.96	5.46	207.33	11.69	320.01	ARIMA(4, 1, 2)
							Q-stat: 14.106 (0.294)
4	Sendhwa (Madhya Pradesh)	0.91	7.48	268.58	12.65	438.38	ARIMA (13, 1, 8)
							-
5	Rajkot (Gujarat)	0.96	4.59	181.33	11.53	294.74	ARIMA (4, 1, 2)
							Q-stat: 6.511 (0.888)
6	Gondal (Gujarat)	0.96	5.18	197.37	11.58	310.12	ARIMA (3, 1, 1)
							Q-stat:14.122 (0.441)

Cross-validation of the selected model

In order to check the validity of these forecast values, one has to compare its forecasting performance against out-of-sample data for post sample forecast period *i.e.*, from January-2022 to December-2022. The Cross-validation of the selected best-fit ARIMA model for all the selected markets is furnished in

Table 2. The absolute percentage errors of the individual years indicated minimal deviation of the predicted values from that of the actual values with average margin of forecast error of -24.24 per cent in Adoni market, -11.27 per cent in Parbhani market, -10.41 per cent in Budalada, -28.92 per cent in Sendhwa market, -24.08 per cent in Rajkot market, and -18.42 per cent in Gondal market, confirming the successful cross-validation of the selected model.

Table 2: Post sample period forecasts for cotton prices of selected national markets based on the respective best fit ARIMA model.

Monthly prices	Adoni (Andhra Pradesh)			Parbhani (Maharashtra)			Budalada (Punjab)		
	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)
Jan-22	8724	7757	-11.08	9674	8015	-17.14	8687	7803	-10.18
Feb-22	9163	7550	-17.61	10120	7802	-22.91	8856	7864	-11.20
Mar-22	9040	7290	-19.36	10598	7819	-26.22	8969	7933	-11.55
Apr-22	9876	7146	-27.65	11473	8018	-30.11	8723	7895	-9.49
May-22	11932	7003	-41.31	9200	8245	-10.38	9222	7904	-14.29
Jun-22	10788	6912	-35.93	11151	8313	-25.45	10598	7991	-24.60
Jul-22	9536	6853	-28.14	9360	8203	-12.36	10039	7986	-20.45
Aug-22	9536	6791	-28.79	8630	8092	-6.23	9480	7960	-16.03
Sep-22	9058	6781	-25.14	8130	8152	0.27	7954	8035	1.02
Oct-22	8303	6739	-18.84	7630	8375	9.76	8500	8070	-5.06
Nov-22	8469	6753	-20.26	8543	8580	0.43	8540	8032	-5.95
Dec-22	8085	6728	-16.79	8183	8597	5.06	7850	8076	2.88
Average			-24.24			-11.27			-10.41

Monthly prices	Sendhwa (Madhya Pradesh)			Rajkot (Gujarat)			Gondal (Gujarat)		
	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)
Jan-22	9133	7012	-23.22	9093	8092	-11.01	9365	8403	-10.27
Feb-22	9459	6831	-27.78	9839	7627	-22.48	10052	8250	-17.93
Mar-22	9272	7046	-24.01	9704	7555	-22.15	11472	8212	-28.42
Apr-22	9126	6718	-26.39	11476	7562	-34.11	11245	8162	-27.42
May-22	10151	6273	-38.20	11804	7568	-35.89	11574	8105	-29.97
Jun-22	10525	6306	-40.09	11571	7509	-35.11	11941	8055	-32.54
Jul-22	11000	6772	-38.44	10240	7450	-27.25	10012	8014	-19.96
Aug-22	9860	6364	-35.46	10578	7403	-30.02	9805	7978	-18.63
Sep-22	7474	5770	-22.80	9643	7374	-23.53	9599	7947	-17.21
Oct-22	7793	5918	-24.06	8632	7349	-14.86	8551	7921	-7.37
Nov-22	8178	6071	-25.76	9050	7326	-19.05	8427	7900	-6.25
Dec-22	7658	6064	-20.82	8449	7305	-13.54	8302	7883	-5.05
Average			-28.92			-24.08			-18.42

Fitting of Seasonal ARIMA model to selected cotton markets: SARIMA model with the mix modelling approach of Autoregressive (AR) and Moving Average methods (MA) as such an approach is bound to take care of the trends, cycles, non-stationary, and stationarity aspects of the data set while generating forecast values. The SARIMA methodology was carried out in the same way of ARIMA in five steps, *viz.* (1) Identification, (2) Estimation, (3) Diagnostic Checking or Model Validation, (4) Cross-validation and (5) Forecasting. Model Identification has been done similarly as done in ARIMA model.

Selecting the candidate model for forecasting

Based upon the conditions, like the highest values of adjusted R^2 and the lowest values of Mean Absolute Percentage Error (MAPE the following expected SARIMA models as furnished in Table 4.108, $(2,1,1)\ (1,1,1)_{12,}$ $(6,1,6)\ (1,1,1)_{12,}$ $(3,1,1)\ (1,1,1)_{12,}$ $(8,1,2)\ (2,1,1)_{12,}$ $(3,1,3)\ (1,1,1)_{12,}$ $(3,1,1)\ (2,1,1)_{12}$, were selected for Adoni (Andhra Pradesh), Parbhani (Maharashtra), Budalada (Punjab), Sendhwa (Madhya Pradesh), Rajkot (Gujarat), Gondal (Gujarat), markets, respectively.

Table 3: Summary of the selected SARIMA models for forecasting monthly cotton prices in selected cotton markets

SL. No.	Market	Market selection criteria					Selected SARIMA model
		Adj- R^2	MAPE	MAE	RMSE	BIC	
1	Adoni (Andhra Pradesh)	0.95	6.18	218.3	330.6	11.7	$(2, 1, 1)\ (1, 1, 1)_{12}$
							Q-stat: 10.977 (0.613)
2	Parbhani (Maharashtra)	0.91	6.67	266.5	449.3	12.6	$(6, 1, 6)\ (1, 1, 1)_{12}$
							Q-stat: 7.087 (0.131)
3	Budalada (Punjab)	0.95	5.58	215.1	327.0	11.7	$(3, 1, 1)\ (1, 1, 1)_{12}$
							Q-stat: 11.473 (0.489)
4	Sendhwa (Madhya Pradesh)	0.88	8.04	295.0	469.2	12.6	$(8, 1, 2)\ (2, 1, 1)_{12}$
							Q-stat: 8.999 (0.109)
5	Rajkot (Gujarat)	0.96	4.81	192.8	302.7	11.6	$(3, 1, 3)\ (1, 1, 1)_{12}$
							Q-stat: 6.645 (0.827)
6	Gondal (Gujarat)	0.95	5.86	218.7	328.3	11.7	$(3, 1, 1)\ (2, 1, 1)_{12}$
							Q-stat: 7.823 (0.729)

Further, the selected SARIMA models also turned out to be adequate for forecasting with the Q-values (L- Jung box stat) being non-significant (Table 3).

Cross-validation of the selected model

The Table 4 shows the market wise predicted price values of the selected model being contrasted with the actual price values from January 2022 to December 2022. The absolute percentage errors of the individual years indicated minimal deviation of the predicted values from that of the actual values with average margin of forecast error of -15.80 per cent in Adoni market, -16.43 per cent in Parbhani market, -11.26 per cent in Budalada, -11.83 per cent in Sendhwa market, -22.51 per cent in Rajkot market, and -18.67 per cent in Gondal market, confirming the successful cross-validation of the selected model.

Table 4: Post sample period forecasts for cotton prices of selected national markets based on the respective best fit model.

Monthly prices	Adoni (Andhra Pradesh)			Parbhani (Maharashta)			Budalada (Punjab)		
	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)
Jan-22	8724	8184	-6.19	9674	8231	-14.92	8687	7968	-8.28
Feb-22	9163	7823	-14.62	10120	8042	-20.53	8856	8017	-9.47
Mar-22	9040	7791	-13.82	10598	7592	-28.36	8969	8086	-9.85
Apr-22	9876	7868	-20.33	11473	7549	-34.20	8723	8025	-8.00
May-22	11932	7726	-35.25	9200	7226	-21.46	9222	7951	-13.78
Jun-22	10788	7762	-28.05	11151	7739	-30.60	10598	7944	-25.04
Jul-22	9536	7960	-16.53	9360	7555	-19.28	10039	7946	-20.85
Aug-22	9536	8043	-15.66	8630	7523	-12.83	9480	7803	-17.69
Sep-22	9058	7931	-12.44	8130	7395	-9.04	7954	7604	-4.40
Oct-22	8303	7653	-7.83	7630	7637	0.09	8500	7709	-9.31
Nov-22	8469	7475	-11.74	8543	8306	-2.77	8540	7831	-8.30
Dec-22	8085	7503	-7.20	8183	7921	-3.20	7850	7839	-0.14
Average			-15.80			-16.43			-11.26

Monthly prices	Sendhwa (Madhya Pradesh)			Rajkot (Gujarat)			Gondal (Gujarat)		
	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)	Actual prices (Rs./qtl.)	Predicted Prices (Rs./qtl.)	Error margin (%)
Jan-22	9133	7462	-18.30	9093	8139	-10.49	9365	8624	-7.91
Feb-22	9459	7454	-21.20	9839	7588	-22.88	10052	8388	-16.55
Mar-22	9272	7811	-15.76	9704	7527	-22.43	11472	8276	-27.86
Apr-22	9126	7659	-16.07	11476	7801	-32.02	11245	8180	-27.26
May-22	10151	7247	-28.61	11804	7820	-33.75	11574	7982	-31.04
Jun-22	10525	7618	-27.62	11571	7714	-33.33	11941	7988	-33.10
Jul-22	11000	8037	-26.94	10240	7776	-24.06	10012	7965	-20.45
Aug-22	9860	8800	-10.75	10578	7764	-26.60	9805	7917	-19.26
Sep-22	7474	7598	1.66	9643	7654	-20.63	9599	7809	-18.65
Oct-22	7793	7819	0.33	8632	7318	-15.22	8551	7703	-9.92
Nov-22	8178	8739	6.86	9050	7482	-17.33	8427	7877	-6.53
Dec-22	7658	8759	14.38	8449	7492	-11.33	8302	7841	-5.55
Average			-11.83			-22.51			-18.67

3. Forecasting using the best fitted model

The forecasting performance of fitted model was studied by comparison of forecast performance *i.e.* mean absolute percentage error (MAPE), coefficient of determination (R^2). Results of cross validation of each fitted model has been compared and model with lesser percentage of absolute error margin was selected as best fit model. On the basis of comparison, SARIMA model has been used for future price forecasts of cotton for the onward period from Jan-23 to Dec-23 in Adoni, Sendhwa, cotton markets. In case of Sendhwa market, the fitted ARIMA model was not adequate due to the non-significant results of Ljung box test. Hence, SARIMA was used in Sendhwa market for future price forecasts of cotton. Whereas, in Parbhani, Budalada, Rajkot, Gondal and India H-4 market, ARIMA model was used for forecasts of cotton prices for the onward period from Jan-23 to Dec-23.

Following cross-validation, the ex-ante forecasts for the onward period from Jan-23 to Dec-23 was carried out and the forecast values of cotton prices in selected markets were presented in Table 5 with lower and upper limit. From the Table, it can be seen an increasing trend in the forecast values from May to August. In Adoni market, highest predicted value found in August month with 8468.07 (Rs./qtl), whereas, in Parbhani, Budalada, Sendhwa and Rajkot markets, the predicted values were found higher in November month with 9380.47(Rs,/qtl), 8440.35(Rs,/qtl), 8809.70(Rs,/qtl), 8927 (Rs,/qtl), respectively. Moreover, in Gondal market, the predicted prices were found higher in month of December. Higher values found in November and December in all national markets, because in pre-harvest period prices tends to be high. Similar results were found by Darekar and Reddy (2017) [2-3] in their study on price forecasting of maize in major states. Their forecast results showed that market prices of maize, would be ruling in the range of Rs. 1,200 - 1,600 per quintal in kharif harvesting season, 2017-18. The prices of maize in the market during September to December 2017-18 would be high in Madhya Pradesh Andhra Pradesh and Rajasthan. Besides, Kumar and Baishya (2020) [6] noted the similar results in same lines.

Table 5: Forecast values of the monthly cotton market prices by using the best-fit models

Monthly prices	Adoni (Andhra Pradesh) SARIMA (2, 1, 1) (1, 1, 1)			Parbhani (Maharashtra) ARIMA (4, 1, 3)			Budalada (Punjab) ARIMA (4, 1, 2)		
	Forecast prices (Rs./qtl.)	Lower limit	Upper limit	Forecast prices (Rs./qtl.)	Lower limit	Upper limit	Forecast prices (Rs./qtl.)	Lower limit	Upper limit
Jan-23	8129.40	7404.75	8854.04	8530.11	7104.02	10158.37	7911.54	7233.04	8590.05
Feb-23	7968.78	6918.01	9019.55	8638.68	6824.10	10788.86	8219.90	7301.07	9138.72
Mar-23	8023.36	6759.05	9287.67	8535.10	6521.26	10977.25	8271.21	7157.45	9384.97
Apr-23	8099.18	6683.01	9515.34	8949.04	6648.50	11793.24	8022.05	6714.63	9329.46
May-23	7933.73	6404.25	9463.21	8624.98	6271.54	11577.64	7952.24	6474.02	9430.46
Jun-23	7971.14	6354.55	9587.73	9030.66	6436.26	12330.29	8213.00	6603.05	9822.95
Jul-23	8369.11	6684.20	10054.01	8888.02	6220.90	12321.94	8377.26	6651.72	10102.79
Aug-23	8468.07	6728.81	10207.34	8953.66	6166.47	12581.38	8201.08	6351.05	10051.10
Sep-23	8345.42	6562.41	10128.42	9204.97	6234.97	13113.98	8039.35	6063.42	10015.28
Oct-23	8288.60	6470.08	10107.11	8922.99	5958.04	12862.80	8208.67	6126.80	10290.55
Nov-23	8228.66	6381.06	10076.25	9380.47	6169.27	13690.71	8440.35	6267.79	10612.91
Dec-23	8234.86	6363.29	10106.44	9084.67	5892.83	13408.24	8367.72	6100.05	10635.40

Monthly prices	Sendhwa (Madhya Pradesh) SARIMA (8, 1, 2) (2, 1, 1)			Rajkot (Gujarat) ARIMA (4, 1, 3)			Gondal (Gujarat) ARIMA (3, 1, 1)		
	Forecast prices (Rs./qtl.)	Lower limit	Upper limit	Forecast prices (Rs./qtl.)	Lower limit	Upper limit	Forecast prices (Rs./qtl.)	Lower limit	Upper limit
Jan-23	8158.68	7165.10	9152.26	8525	7718	9363	8275.85	7578.91	8972.78
Feb-23	8059.68	6817.42	9301.93	8446	7196	9767	8307.97	7238.13	9377.81
Mar-23	8067.81	6644.90	9490.72	8587	7039	10247	8316.39	6979.81	9652.97
Apr-23	8127.83	6537.83	9717.84	8640	6878	10547	8344.71	6767.42	9921.99
May-23	8492.91	6773.82	10212.00	8569	6625	10693	8362.69	6584.41	10140.98
Jun-23	8507.36	6681.72	10333.00	8769	6629	11123	8386.80	6423.47	10350.13
Jul-23	8343.89	6404.56	10283.23	8623	6347	11148	8407.58	6277.42	10537.73
Aug-23	8567.03	6484.35	10649.70	8812	6361	11548	8430.22	6144.20	10716.23
Sep-23	7942.05	5742.76	10141.33	8765	6189	11660	8451.83	6020.53	10883.13
Oct-23	8512.65	6232.57	10792.74	8794	6083	11859	8474.01	5905.31	11042.72
Nov-22	8809.70	6450.35	11169.04	8927	6074	12168	8495.88	5796.93	11194.83
Dec-22	8518.32	6057.11	10979.53	8804	5858	12174	8517.93	5694.64	11341.21

Conclusion

The nature and extent of price fluctuations provides necessary guidance to farmers for marketing the products efficiently. The research was carried out using the secondary data for period from January, 2001 to December, 2021 for this analysis. ARIMA and SARIMA model were used to forecast the future cotton prices in the selected markets using the SPSS software. The results found that it can be seen an increasing trend in the forecast values from May to August. In Adoni market, highest predicted value found in August month with 8468.07 (Rs./qtl), whereas, in Parbhani, Budalada, Sendhwa and Rajkot markets, the predicted values were found higher in November month with 9380.47 (Rs,/qtl), 8440.35 (Rs,/qtl), 8809.70 (Rs,/qtl), 8927 (Rs,/qtl), respectively. Moreover, in Gondal market, the predicted prices were found higher in month of December. Higher values found in November and December in all national markets, because in pre-harvest period prices tends to be high.

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