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Price Behaviour and Forecasting of Cotton in Telangana

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ABSTRACT

Cotton is the most important cash crop in Telangana. Area under cotton crop has increased in Telangana over a period of time continuously with the introduction of Bt cotton and also favorable market prices. Cotton area has increased from 11.60 lakh hectares in 2009-10 to 16.97 lakh hectares in 2015-16. To know the cotton price behaviour over the years and short term price forecast in Telangana we taken up the study on "Price Behavior of Cotton in Telangana". The average monthly cotton price data of 16 years from 2002 April to May 2017 was used for price forecasting. Based on percentage share of total commodity arrivals 5 major markets are Warangal, Adilabad, Bainsa, Peddapalli and Karimnagar selected. In order to assess the presence of price fluctuation in the cotton prices in five major markets, ARCH-GARCH analysis was carried out. The results of ARCH-GARCH analysis indicate that the sum of Alpha and Beta is not nearer to 1 in any of major market for all the selected markets. This clearly indicates that the volatility shocks are not quite persistent in major markets for cotton. Monthly average prices (Rs/Quintal) of cotton in selected markets from January 2014 to December 2016 revealed that cotton prices were found to be maximum during the months March to May and also October, while remaining almost stable during the rest of the months. The monthly average data from 2002 to 2016 results show that cotton prices increasing year by year high prices are present at March 2011 (Rs. 5381), monthly average for overall years is very high present in the month of February and Yearly average for overall months is very high present in the year 2016. ARIMA 212 results revealed that price forecasting of cotton for the harvesting months i.e. November, December and January as followed Rs. 4889, 4824 and 4842 per quintal respectively. Based on the past 16 years data i.e. April 2002 to May 2017 and ARIMA 212 model the forecasted price showed that increasing trend in Warangal market.

Key words: *Stationarity, Differencing, Volatility, ARIMA, ARCH-GARCH, Price forecast*

INTRODUCTION

Agriculture is the mainstay in Telangana, as more than half of the State's population depends on it for their livelihood. A stable and high growth in agriculture sector is essential for uplifting the standard of living of rural population. Cotton is one of the important fibre and cash crops in India and plays a dominant role in the industrial and agricultural economy of the country. Cotton has been in cultivation in India for more than five thousand years.

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The major cotton producing countries are USA, China, India, Pakistan, Uzbekistan, Egypt, Argentina, Australia, Greece, Brazil and Turkey. These countries contribute about 85 per cent to the global cotton production.

In India cotton crop is grown throughout the country. However, there are nine major cotton producing states, *viz*., Punjab, Haryana, Andra Pradesh, Madhya Pradesh, Maharashtra, Gujarat, Telangana, Karnataka and Tamil Nadu. The states of Gujarat, Maharashtra and Telangana are the major producers of cotton in India, accounting for 68 per cent of the country's total output. India is currently the world's second largest exporter of cotton. In India, Telangana ranks 3rd in area and production, and 6th in productivity. Cotton is one of the major traditional commercial crops grown in Telangana state. The advent of new cotton hybrids and revolution of Bt cotton technology coupled with suitable agro-climatic conditions might have contributed for significant rise in area, production and productivity of cotton in the state. In Telangana, major cotton growing districts are Adilabad, Karimnagar, Warangal, Khammam and Nalgonda and these districts cover about 84 per cent of the total cotton area. Kastens *et al*. studied futures – based price forecasts for agricultural producers and businesses. He compared relative forecasting accuracy across forecast methods using regression models of forecast error. Adding complexity to forecast, such as including regression models to capture nonlinear bases or biases in futures markets, does not improve accuracy. The traditional forecast method of deferred futures plus historical basis has the greatest accuracy. Praneshu *et al*[3]., in their study found that structural time series modeling is best model over ARIMA model to predict observations that are regarded as made up of distinct component such as trend and cyclical fluctuations. The techniques that emerge from this approach are extremely flexible and are capable of handling a much wider range of problem than is possible through ARIMA approach. Havaldhar *et al*[2]., studied price forecasting of vegetables. In their study weekly, monthly and yearly data were considered to know the differences in the results through moving average method for 8 years that is from 1996-2003. The results indicate that weekly set of data resulted in true and exact periods in which seasonal low and high exists as compared to other set of data to analyse the seasonal behavior of arrivals and prices of vegetables. Bharathi *et al*[1]., studied forecasting of arrivals and prices of cocoons in Ramnagar market. ARIMA model was used for forecasting of arrivals and prices. Suitable model was identified based on the ACF and PACF. The adequacy of the model was udged based on Akaike Information criterion and Mean Square Error. Model ARIMA113, ARIMA111 was identified for price forecasting. Forecasted values of arrivals showed increasing trend in both the market and price showed decreasing trend in sidlaghatta market.

MATERIALS AND METHODS

Data source:

The average monthly cotton price data of 16 years from April 2002 to May 2017 was used for price forecasting, data were collected from the official website of agricultural marketing department of Telangana state http://agrimarketing.telangana.gov.in/ formed the source of secondary information on prices of cotton. The major criterion for market selection for cotton commodity is the arrivals. Based on percentage share of total commodity arrivals 5 major markets are Warangal, Adilabad, Bainsa Peddapalli and Karimnagar.

Stationarity

The noise (or residual) series for an ARMA model must be *stationary*, which means that both the expected values of the series and its auto covariance function are independent of time. The standard way to check for non stationarity is to plot the series and its autocorrelation function. You can visually examine a graph of the series over time to see if it has a visible trend or if its variability changes noticeably over time. If the series is non stationary, its autocorrelation function will usually decay slowly. Another way of checking for stationarity is to use the stationarity tests. Most time series are non stationary and must be transformed to a stationary series before the ARIMA modeling process can proceed. If the series has a trend over time, seasonality, or some other non stationary pattern, the usual solution is to take the difference of the series from one period to the next and then analyze this differenced series. Sometimes a series may need to be differenced more than once or differenced at lags greater than one period. (If the trend or seasonal effects are very regular, the introduction of explanatory variables may be an appropriate alternative to differencing.)

Differencing

A deterministic seasonal pattern will also cause the series to be non stationary, since the expected value of the series will not be the same for all time periods but will be higher or lower depending on the season. When the series has a seasonal pattern, you may want to difference the series at a lag corresponding to the length of the cycle of seasons. To take a second difference, add another differencing period to the list. There is no limit to the order of differencing and the degree of lagging for each difference.

ARIMA Process

Auto Regressive Integrated Moving Average (ARIMA) Model (Process): This process is an amalgamation to ARMA process when the time series {Yt} is Non-Stationary or "Integrated". It is obvious that to develop the ARMA model in this situation, the series has to be "differenced" to make it stationary and this differenced series, which is now stationary has to be subjected to fitting of ARMA model. This process is referred as ARIMA (p, d, q), where p and q refer to the number of AR and MA terms and d refers to the order of differencing required for making the series a Stationary. The characteristics of the time series models, i.e., the parameters (p, d, q) and thereafter the estimation of the relevant model can be carried out in a planned approach outlined by Box and Jenkins methodology.

The methodology involves the following four steps

1. Identification of the characteristics (p, d, q) for the Model
2. Estimation
3. Diagnostics Checking
4. Forecasting

1. Identification of the characteristics (p, d, q) for the Model: The foremost step in the process of modeling is to check for the stationarity of the series, as the estimation procedures are available only for stationary series. If the original series is non stationary then first of all it should be made stationarity.

2. Estimation: On the basis of identification of the parameters (p, d, q) the series is subjected to fitting of the appropriate ARIMA (p, d, q) model. The procedure for fitting the model involves transforming the series through appropriate differencing, in case it is non-stationary, and then subjecting the differenced series to fitting. Choice of parameters on the basis of significant ACFs and PACFs**.**

3. Diagnostics: Based on the ACFs and PACFs: In the model-building process, if an ARIMA (p, d, q) model is chosen (based on the ACFs and PACFs), some checks on the model adequacy are required. A residual analysis is usually based on the fact that the residuals of an adequate model should be approximately white noise. Therefore, checking the significance of the residual autocorrelations and comparing with approximate two standard error bounds, i.e., $\pm 2/\sqrt{n}$ are need.

Two criteria for model selection:

Akaike's information criterion (AIC):

$$AIC = \log \hat{\sigma}^2 + 2\frac{p+q}{n}$$

Where $\hat{\sigma}^2$ is the estimated variance of e_t.

Schwarz's Bayesian Information criterion (SC, BIC, or SBC):

$$BIC = \log \hat{\sigma}^2 + 2\frac{p+q}{n}\log(n)$$

Both criteria are likelihood-based and represent a different trade-off between "fit", as measured by the log-likelihood value, and "parsimony", as measured by the number of free parameters, p + q. If a constant is included in the model, the number of parameters is increased to p+ q+ 1. Usually, the model with the smallest AIC or BIC values are preferred. While the two criteria differ in their trade-off between fit and parsimony, the BIC criterion can be preferred because it has the property that it will almost surely select the true model.

4. Forecasting: The model that satisfies all the diagnostic checks is considered for forecasting.

ARCH:

Autoregressive conditional heteroscedasticity (ARCH) is the condition that one or more data points in a series for which the variance of the current error term or innovation is a function of the actual sizes of the previous time periods' error terms: often the variance is related to the squares of the previous innovations. In econometrics, ARCH models are used to characterize and model time series. ARCH models are commonly employed in modeling financial time series that exhibit time-varying volatility clustering, i.e. periods of swings interspersed with periods of relative calm. ARCH-type models are sometimes considered to be in the family of stochastic volatility models, although this is strictly incorrect since at time *t* the volatility is completely pre-determined given previous values.

GARCH:

If an autoregressive moving average model (ARMA model) is assumed for the error variance, the model is called a generalized autoregressive conditional heteroscedasticity (GARCH) model.

RESULTS AND DISCUSSION

Testing stationarity

Stationarity tests can be performed to identify whether differencing is necessary. To check the stationarity of price series of cotton, the Augmented Dickey Fuller unit root tests were used. It is observed from the table that original series at level with lag 1, the ADF values are below the critical value at 5% level of significance indicating that no existence of unit root, hence differencing at level with lag 1, the ADF values are above the critical value at 5% level of significance indicating the existence of unit root.

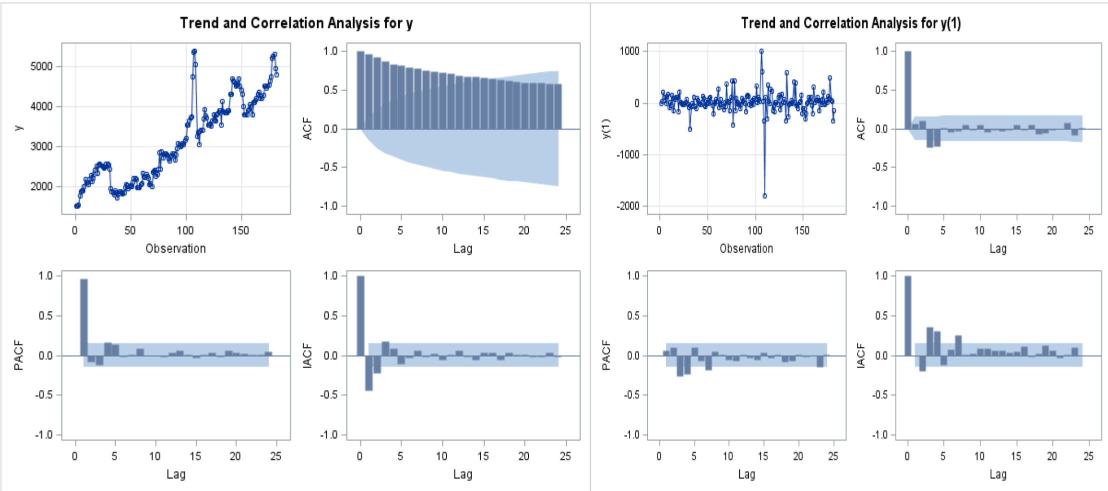
Original series:

Augmented Dickey-Fuller Unit Root Tests							
Type	Lags	Rho	Pr < Rho	Tau	**Pr < Tau**	F	Pr > F
Zero Mean	6	0.7471	0.8639	1.09	**0.9277**		
	8	0.7529	0.8651	1.26	**0.9472**		
Single Mean	6	-1.9184	0.7867	-0.79	**0.8184**	1.27	0.7464
	8	-0.9227	0.8922	-0.44	**0.8982**	1.16	0.7762
Trend	6	-26.0699	0.0159	-2.98	**0.1402**	4.51	0.2768
	8	-22.4085	0.0365	-2.73	**0.2271**	3.90	0.3985

Differenced series:

Augmented Dickey-Fuller Unit Root Tests							
Type	Lags	Rho	Pr < Rho	Tau	**Pr < Tau**	F	Pr > F
Zero Mean	6	270.7662	0.9999	-6.79	**<.0001**		
	8	879.9273	0.9999	-5.03	**<.0001**		
Single Mean	6	222.4777	0.9999	-7.00	**<.0001**	24.53	0.0010
	8	337.2845	0.9999	-5.25	**<.0001**	13.79	0.0010
Trend	6	219.9264	0.9999	-7.00	**<.0001**	24.48	0.0010
	8	323.5298	0.9999	-5.25	**0.0001**	13.80	0.0010

Before Differencing **After Differencing**



Conditional Least Squares Estimation					
Parameter	Estimate	Standard Error	t Value	**Approx Pr > |t|**	Lag
MU	17.48876	17.63786	0.99	**0.3228**	0
MA1,1	-0.64213	0.04344	-14.78	**<.0001**	1
MA1,2	-0.93198	0.04446	-20.96	**<.0001**	2
AR1,1	-0.56923	0.08477	-6.71	**<.0001**	1
AR1,2	-0.64277	0.08546	-7.52	**<.0001**	2

Forecasts for variable y				
Month	**Forecast**	Std Error	95% Confidence Limits	
NOV	**4889.7009**	207.6747	4482.6660	5296.7359
DEC	**4824.1885**	304.5894	4227.2042	5421.1728
JAN	**4842.5053**	409.8662	4039.1824	5645.8282

Forecasts for variable y				
Month	**Forecast**	Std Error	95% Confidence Limits	
S.No.	**ARIMA**	AIC	SBC	MAPE
1	**ARIMA 110**	2467.64	2474.10	6.40
2	**ARIMA 112**	2460.00	2472.80	9.31
3	**ARIMA 210**	2461.60	2471.20	6.83
4	**ARIMA 211**	2459.30	2470.15	6.3
5	**ARIMA 212**	2450.20	2466.2	6.03

Based on the performance results of different forecasting models, ARIMA 212 was preferred mainly because of the lowest Akaike Information Criterion, lowest Schwarz's Information criterion, Mean Absolute Percentage Error (MAPE) and parameters significant at 1% level of significance. ARIMA 212 results revealed that price forecasting of cotton for the harvesting months i.e. November, December and January as followed Rs. 4889, 4824 and 4842 per quintal respectively.

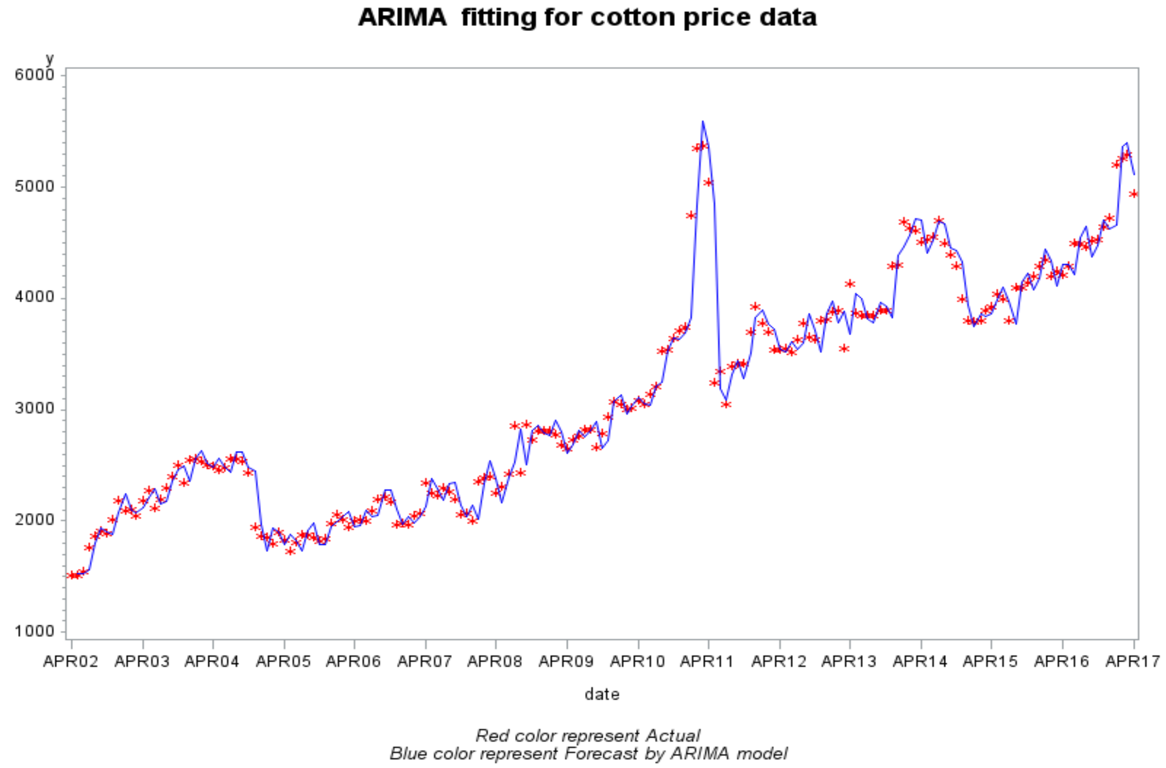


Fig. 1: Actual and Forecasted prices of cotton from April 2002 to May 2017

Volatility / stability among major markets

In order to assess the presence of price fluctuation in the prices of selected commodities in their major markets, ARCH-GARCH analysis was carried out. The results of ARCH-GARCH analysis indicate that the sum of Alpha and Beta is not nearer to 1 in any of major market for all the selected markets. This clearly indicates that the volatility shocks are not quite persistent in major markets for cotton.

Table 1: Results of ARCH-GARCH Analysis for cotton prices in major markets

Parameter	Adilabad	Bainsa	Karimnagar	Peddapalli	Warangal
Alpha (α)	0.54	-0.08	-0.09	-0.09	1.15
Beta (β)	-0.19	0.44	0.45	0.45	-0.80
Sum of α &β	0.35	0.36	0.36	0.36	0.35

Table 2: Monthly average prices (Rs/Quintal) of cotton in selected markets from January 2014 to December 2016

	Adilabad	Bainsa	Karimnagar	Peddapalli	Warangal
Jan	4271	4217	4067	4203	4277
Feb	4272	4350	4172	4139	4213
Mar	4183	4407	4500	4367	4257
Apr	4323	4217	4433	4221	4220
May	4434	4283	4217	4294	4291
Jun	4341	4150	4188	4289	4352
Jul	4395	4370	4202	4348	4333
Aug	4400	4375	4222	4272	4357
Sep	4283	4350	4200	4217	4342
Oct	4317	4482	4323	4434	4327
Nov	4200	4388	4378	4382	4283
Dec	4338	4399	4432	4455	4277

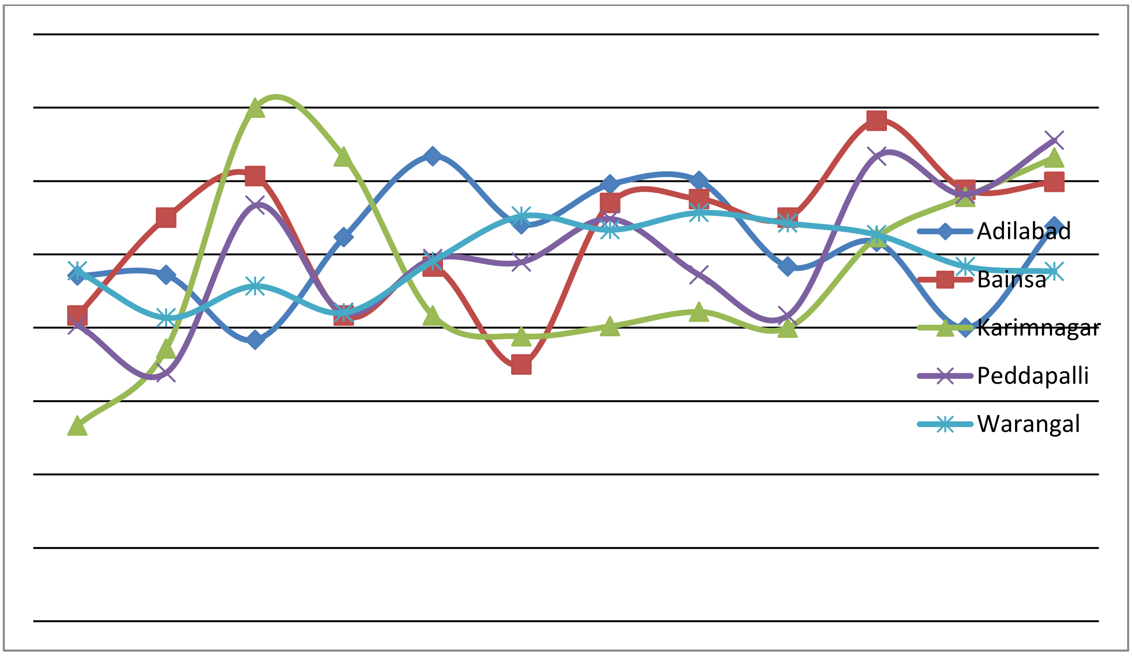


Fig 2: Monthly average prices (Rs/Quintal) of cotton in selected markets from January 2014 to December 2016

Monthly average prices (Rs/Quintal) of cotton in selected markets from January 2014 to December 2016 showed in Fig. cotton prices were found to be maximum during the months March to May and also October, while remaining almost stable during the rest of the months.

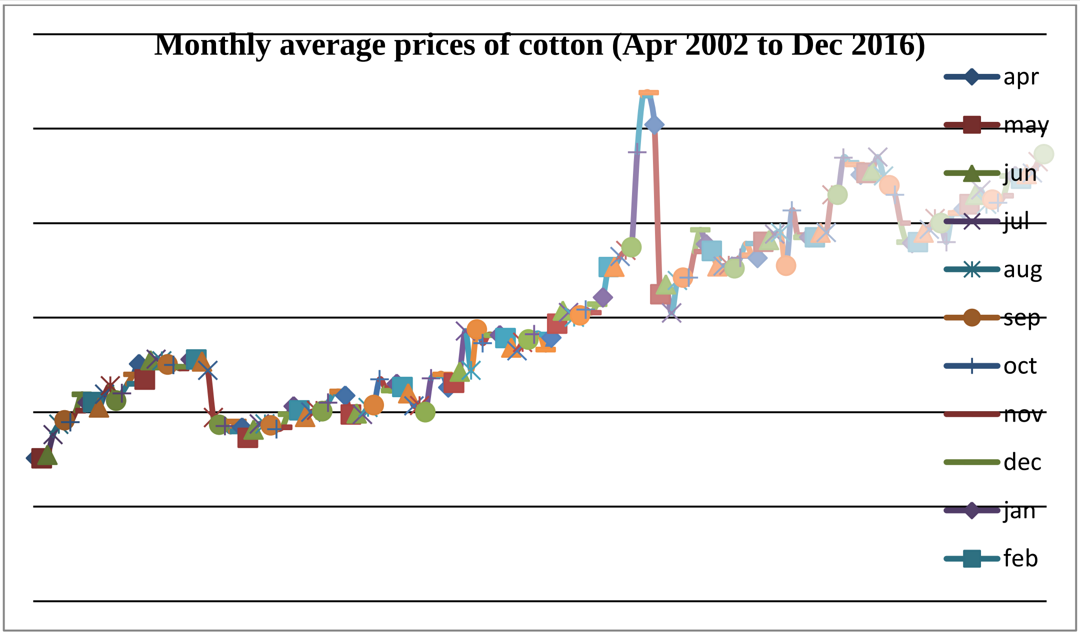


Fig. 3: Monthly average prices of cotton

The monthly average data from 2002 to 2016 were showed in Table3. Results show that cotton prices increasing year by year high prices are present at March 2011 (Rs. 5381), monthly average for overall years is very high present in the month of February and Yearly average for overall months is very high present in the year 2016.

Table 3: Monthly average prices of cotton

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Monthly average for overall years
January		2101	2560	1854	2062	1975	2358	2815	3055	4750	3779	3884	4693	3789	4350	3144.64
February		2105	2544	1795	2018	2050	2388	2784	3003	5350	3706	3900	4640	3800	4200	3163.07
March		2050	2505	1900	1950	2075	2400	2684	3024	5381	3543	3550	4620	3900	4250	3130.86
April	1513	2190	2500	1837	2000	2346	2261	2649	3084	5042	3546	4133	4512	3934	4215	3050.80
May	1511	2280	2463	1727	2018	2256	2310	2738	3053	3247	3554	3875	4532	4050	4290	2926.93
June	1549	2122	2481	1816	2010	2227	2429	2769	3142	3353	3522	3850	4556	4000	4500	2955.07
July	1762	2200	2558	1875	2100	2300	2859	2823	3214	3050	3633	3850	4700	3800	4500	3014.93
August	1872	2300	2558	1875	2200	2267	2442	2822	3535	3393	3784	3850	4500	4100	4470	3064.53
September	1913	2400	2537	1859	2218	2200	2876	2662	3539	3423	3661	3900	4400	4107	4520	3081.00
October	1894	2510	2443	1821	2175	2067	2729	2788	3646	3423	3631	3900	4300	4150	4530	3067.13
November	2016	2346	1943	1840	1975	2069	2819	2937	3711	3699	3802	4300	4000	4200	4650	3087.13
December	2188	2550	1867	1979	1987	2000	2813	3075	3746	3929	3822	4301	3800	4300	4730	3139.13
Years wise average	1802.00	2262.83	2413.25	1848.17	2059.42	2152.67	2557.00	2795.50	3312.67	4003.33	3665.25	3941.08	4437.75	4010.83	4433.75	

CONCLUSION

The price fluctuation of cotton prices in five major markets, ARCH-GARCH analysis was carried out. The results of ARCH-GARCH analysis indicate that the sum of Alpha and Beta is not nearer to 1 in any of major market for all the selected markets. This clearly indicates that the volatility shocks are not quite persistent in major markets for cotton. Monthly average prices (Rs/Quintal) of cotton in selected markets from January 2014 to December 2016 revealed that cotton prices were found to be maximum during the months March to May and also October, while remaining almost stable during the rest of the months. The monthly average data from 2002 to 2016 results show that cotton prices increasing year by year high prices are present at March 2011 (Rs. 5381), monthly average for overall years is very high present in the month of February and Yearly average for overall months is very high present in the year 2016. ARIMA 212 results revealed that price forecasting of cotton for the harvesting months i.e. November, December and January as followed Rs. 4889, 4824 and 4842 per quintal respectively. Based on the past 16 years data i.e. April 2002 to May 2017 and ARIMA 212 model the forecasted price showed that increasing trend in Warangal market.

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