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Cotton Price Forecasting in Major Producing States

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ABSTRACT

India is the largest cotton producing and second largest cotton exporting country. India accounting about 26% of the world cotton production. It has the distinction of having the largest area under cotton cultivation in the world with about 11-12 million hectares and constituting about 40% of the world area under cotton cultivation. Cotton is a global crop with high price fluctuation, which depends on the global business cycles. It is a mostly used as raw material for apparel and cloth industry. In addition to production risk cotton farmers encounter high price risk. Thus, it is important to forecast the cotton prices for the benefit of farmers as well as millers who purchase the cotton. The present study is aimed to forecast the prices of cotton of major producing states of India. The time series data on monthly price of cotton required for the study was collected from the AGMARKNET website from January, 2006 to December, 2016 to forecast prices for *kharif* 2017-18 year harvest months. ARIMA model was employed to predict the future prices of cotton. Model parameters were estimated using the R programming software. The performance of fitted model was examined by computing various measures of goodness of fit viz., AIC, SBC and MAPE. In *Kharif* season the cotton crop is harvested during December to January. Forecast shows that market prices of cotton, would be ruling in the range of ₹ 4,600 – 4,900 per quintal (medium staple cotton) in *kharif* harvesting season, 2017-18.

Keywords: ACF, PACF, ARIMA, auto regression, box and jenkins, forecasting, moving average

Cotton is one of the most important fiber and cash crop of India and plays a dominant role in the industrial and agricultural economy of the country. India is the largest cultivator and producer of cotton in the world and stands at second position in consumption and export of the same. India, China, USA, Pakistan, Brazil, Uzbekistan, Turkey, Australia, Turkmenistan and Mexico are major cotton producing countries in the world. As per the latest USDA report, global cotton production is expected to rise by 8.25% from 23.08 million tonnes in 2016-17 to 24.98 million tonnes in 2017-18. According to the latest report published by International Cotton Advisory Committee (ICAC), world's cotton area is likely to increase by 5% to 30.8 million hectares in 2017-18.

India is the largest cotton producing and second largest cotton exporting country. India accounting about 26% of the world cotton production. It has the distinction of having the largest area under cotton cultivation in the world ranging between 10.9 million hectares to 12.8 million hectares and constituting about 38% to 41% of the world area under cotton cultivation. India is becoming a major exporter of cotton given its competitiveness in producing cotton (Reddy *et al.,* 2012; Rani *et al.,* 2014). The yield per hectare (i.e. 504 kgs to 566 kgs per hectare) is however still lower against the world average of about 701 Kgs to 766 kgs per hectare. Country is expected to make more strides in cotton production in the years to come. According to the Cotton Advisory Board (CAB) estimates the area under cotton in the country has decreased to 105 lakh hectares in 2016-17 from 118.77 lakh hectares in 2015-16. Despite lower area coverage during 2016-17, higher productivity of cotton has resulted into higher production of 33.09 million bales (of 170 kg each), i.e. an increase of 9.06%, as compared to 30.01 million bales during 2015-16. However, it is estimated that there is increase in production because of increase in productivity from 484 kg/ha to 568 kg/ha due to favorable monsoon and other agro-climatic conditions. Major markets for Indian Cotton exports are Bangladesh, Pakistan, Vietnam, Indonesia, Turkey, Thailand etc. In India Gujarat, Maharashtra, Telangana, Andhra Pradesh, Punjab, Haryana, Madhya Pradesh and Karnataka are the major cotton growing states.

The present study is aimed to forecast the prices of cotton of major producing states of India as being largest cotton producing country in world. Cotton plays a dominant role in the industrial and agricultural economy of the country. As the prices of cotton keep changing from time to time, it creates risks to producers, suppliers, consumers, and other parties that involved in marketing and production of cotton. Thus, it is important to forecast the cotton prices. This paper applies Autoregressive Integrated Moving Average (ARIMA) forecasting model, the most popular and widely used forecasting models for uni-variate time series data. Although it is applied across various functional areas, it's application is very limited in agriculture, mainly due to unavailability of required data and also due to the fact that agricultural product depends typically on monsoon and other factors, which the model failed to incorporate. In this context, it is worth mentioning, few applications of ARIMA model for forecasting agriculture product. Applying ARIMA model Hossain *et al.* (2006) forecasted three different varieties of pulse prices namely motor, mash and mung in Bangladesh with monthly data from Jan 1998 to Dec 2000; Wankhede *et al.* (2010) forecasted pigeon pea production in India with annual data from 1950-1951 to 2007-2008; Mandal (2005) forecasted sugarcane production in India; Khin *et al.* (2008) forecasted natural rubber price in world market; Shukla and Jharkharia (2011) forecasted wholesale vegetable market in Ahmedabad; Darekar *et al*. (2015) forecasted onion prices in Lasalgaon and Pimpalgaon market using ARIMA model; Assis *et al.* (2010) forecasted cocoa bean prices in Malaysia along with other competing models; Nochai and Nochai (2006) forecasted palm oil prices in Thailand; Masuda and Goldsmith (2009) forecasted world Soybean productions; Cooray (2006) forecasted Sri Lanka's monthly total production of tea and paddy beyond Sept 1988 using monthly data from January 1988 to September 2004. 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. Burark and Sharma (2012) confirmed the suitability of ARIMA models in agricultural price forecasting. Paul and Das (2010) have attempted forecasting of inland fish production in India by using ARIMA approach. Reddy and Reddy (2011) and Reddy (2012) concluded that there was a co-movement of prices across different states for major agricultural commodities.

MATERIALS AND METHODS

Data collection

Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Haryana are largest cotton producing states in India. As per availability the time series data related to monthly average prices of cotton from AGMARKNET website 11 years (from January, 2006 to December, 2016) has been collected for selected states to forecast the prices. Using the data forecasting of cotton prices was done for *kharif* harvesting months. The ARIMA model analyzes and forecasts time series data. An ARIMA model predicts a value in a response time series as a linear combination of its own past values. The ARIMA approach was first popularized by Box and Jenkins (1976), and ARIMA models are often referred to as Box-Jenkins models. In this study, the analysis performed by ARIMA is divided into four stages.

Identification Stage: The stationary check of time series data was performed, which revealed that the cotton prices were nonstationary. The nonstationary time series data were made stationary by first order differencing and best fit ARIMA models were developed using the data from January 2006 to December 2016 and used to forecast the prices during harvesting season. Candidate ARIMA models were identified by finding the initial values for the orders of non-seasonal parameters "p"and "q". They were obtained by looking for significant spikes in autocorrelation and partial autocorrelation functions. At the identification stage, one or more models were tentatively chosen which seem to provide statistically adequate representations of the available data. Then precise estimates of parameters of the model were obtained by least squares.

Estimation Stage: ARIMA models are fitted and accuracy of the model was tested on the basis of diagnostics statistics.

Diagnostic Checking: The best model was selected based on the following diagnostics:

(i) **Low Akaike Information Criteria (AIC).** AIC [20] is estimated by AIC = (−2log L + 2m), where, $m = p + q$ and L is the likelihood function.

(ii) **Low Akaike Information Criteria (AIC).** Sometimes, SBC [21] is also used and estimated by SBC = log σ2 + ($m$log n)/n.

(iii) **The mean absolute percent error (MAPE)**: It was used as a measure of accuracy of the models.

Forecasting Stage: Future values of the time series are forecasted.

R programming software was used for time series analysis and developing ARIMA models and forecasting cotton prices. These methods have also been useful in many types of situations which involve the building of models for discrete time series and dynamic systems. (Granger and Newbold 1970). Originally ARIMA models have been studied extensively by George Box and Gwilym Jenkins during 1968 and their names have frequently been used synonymously with general ARIMA process applied to time series analysis, forecasting and control.

Ansari and Ahamed (2001) applied ARIMA modeling for time series analysis of world tea prices and industrialized countries export prices. Pravin Arya *et al.* (2005) applied Box-Jenkins Approach for Forecasting Copra Wholesale Price Series. Nochai and Titida (2006) used ARIMA model for forecasting oil palm prices. Punitha (2007) used ARIMA model to forecast the arrivals and prices of maize and ground nut in Hubli and Devangere markets in Karnataka state. Moghaddsi and Bita (2008) Applied econometric model for wheat price forecasting in Iran. Shankar & Prabhakaran (2012) used the ARIMA model for forecasting the milk production in Tamil Nadu. Chaudhari & Tingre (2013) found that ARIMA (1,1,0) was the best fitted model for forecasting of green gram prices in Maharashtra.

RESULTS AND DISCUSSION

1. Identification

Identification of the model was concerned with deciding the appropriate values of (p,d,q) (P,D,Q). It was done by observing Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) values. The Auto Correlation Function helps in choosing the appropriate values for ordering of moving average terms (MA) and Partial Auto-Correlation Function for those autoregressive terms (AR).

2. Estimating the parameters

The number of non-zero coefficients in ACF determines order of MA terms and the number of non-zero coefficients in PACF plots determines order of AR terms. Based on the lowest AIC and BIC, the ARIMA model (1,1,3), (1,1,1), (1,1,2) (0,0,2), (2,1,2), (1,1,2) and (0,1,0) was the best fitted model for Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Haryana and India respectively. The results of these coefficients are given in Table 1. The ACF and PACF

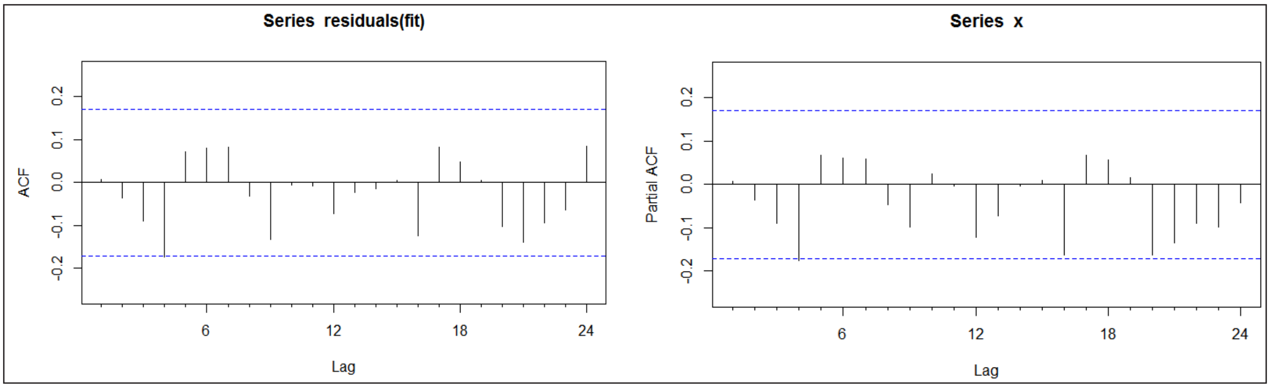

Fig. 1: Autocorrelation function (ACF) and Partial autocorrelation function (PACF) of residuals of fitted ARIMA

suggest that there is no significant correlation to be captured by an ARMA model (Fig. 1).

ARIMA model was estimated after transforming the variables under study into stationary series through computation of either seasonal or non-seasonal or both, order of differencing. A careful examination of ACF and PACF up to 24 lags revealed the presence of seasonality in the data. However, the series was found to be stationary, since the coefficient dropped to zero after the second lag.

3. Diagnostic checking

Preceding 11 years (2006 - 2016) monthly prices data used for this model. Various methods and literature are studied to judge the appropriate model, the best model has been selected based on the maximum absolute percentage error. (MAPE), minimum Akaike Information Coefficient (AIC) and minimum Bayesian information criterion (BIC). It has been found that ARIMA (1,1,3), (1,1,1), (1,1,2) (0,0,2), (2,1,2), (1,1,2) and (0,1,0) model is the best fit for the cotton price data of Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Haryana and India respectively. (Table 1). Forecast for the seasonally adjusted cotton prices by using best fit ARIMA model in R programing software shown in Fig. 2.

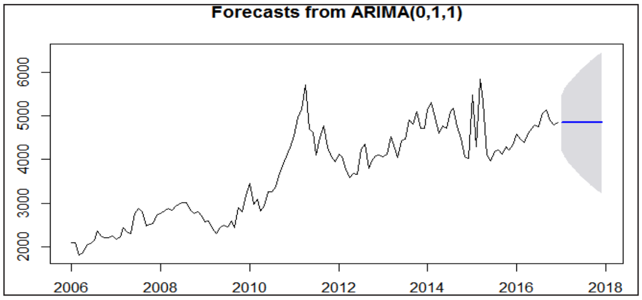

Fig. 2: Forecast for the seasonally adjusted cotton prices in India

4. Forecasting

The results of forecast of prices of cotton in the market are shown in the Table 2. The forecasts indicate that there are narrow variations in between the actual and forecasted values of prices of cotton in the selected states. In *Kharif* season the cotton crop is harvested during December to January. Forecast shows that market prices of cotton, would be ruling in the range of ₹ 4,500 – 4,900 per quintal in *kharif* harvesting season, 2017-18. The prices of cotton in the market during harvesting period would be high in Karnataka, Andhra Pradesh and Maharashtra i.e. ₹ 4,500, 4,450 and 4,400 per q respectively. The prices would be low i.e. ₹ 4,350 and 4,300 per q in Gujarat and Haryana respectively. Forecasted prices of cotton by using ARIMA (0,1,0) model in India is shown in Fig. 3. This forecast is based on past data and model and that actual market price may not turn out to be the same as forecasted.

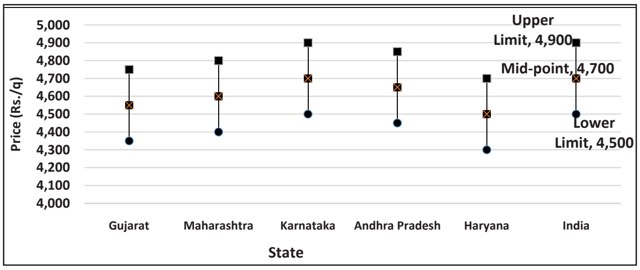

Fig. 3: Forecasted cotton prices in India

The government announced cotton MSP to ₹ 4,020/ quintal (medium staple cotton) for 2017-18. Cotton had been sown on 111.55 lakh hectares till July, as against 92.33 lakh hectares witnessed for the same time last year, thereby indicating an increase of close to 21 per cent in the acreage. However, due to plenty of supply of global and national markets prices will not be much higher than the last year.

Table 1: Residual analysis of monthly prices of cotton in selected states

Sl. No.	State	ARIMA Model	Maxi. Absolute Percentage Error (MAPE)	Akaike Information Coefficient (AIC)	Bayesian Information Criterion (BIC)
1	Gujarat	(1,1,3)	5.20	1871.73	1888.30
2	Maharashtra	(1,1,1)	7.40	1897.79	1906.23
3	Karnataka	(1,1,2) (0,0,2)	5.32	1839.37	1858.58
4	Andhra Pradesh	(2,1,2)	5.46	1863.39	1877.28
5	Haryana	(1,1,2)	5.31	1847.19	1858.37
6	India	(0,1,0)	4.88	1806.61	1812.27

Table 2: Projected prices for cotton in major producing states during *kharif* harvesting season 2017-18 (₹/q)

Sl. No.	State	Lower Limit	Mid-point	Upper Limit
1	Gujarat	4,350	4,550	4,750
2	Maharashtra	4,400	4,600	4,800
3	Karnataka	4,500	4,700	4,900
4	Andhra Pradesh	4,450	4,650	4,850
5	Haryana	4,300	4,500	4,700
6	India	4,500	4,700	4,900

In *Kharif* season the cotton crop is harvested during December to January. Forecast shows that market prices of cotton, would be ruling in the range of ₹ 4,500 – 4,900 per quintal in *kharif* harvesting season, 2017-18. Thus, from foregoing discussion, it is clearly noted that, such forecasting of future cotton prices can help the farmers and the policy makers can also take the decision accordingly. There may be any possible deviation of the actual prices from the predicted prices in light of tentative developments in the commodity markets such as change in international prices, export or import restrictions, etc. And these price forecasts are based on past market price data & different econometric models and that actual market price may not turn out to be the same as forecasted.

CONCLUSION

The Indian economy is moving in free market economy with commodity prices determined by the market forces based on demand and supply conditions. The commercial crops prices are not only depend on domestic demand and supply conditions, but also determined by global supply and demand situations. After liberalization fluctuation in prices increased significantly with lot of uncertainty in profitability of growing commercial crops like cotton. Under this scenario, forecasting future prices (harvest month prices) and disseminating the same to farmers to facilitate informed decisions by farmers before sowing is important. This will help in their choice of crop. The paper used historical monthly prices of cotton in major cotton growing states to forecast future prices for the harvest month by using ARIMA models.

Just like any other method, this technique also does not guarantee perfect forecasts. Nevertheless the model is handy have been successfully used for forecasting in the future. Similar model was used by Almemaychu Amera (2002), Punitha (2007), Darekar *et al.* (2016) and Jalikatti & Patil (2015) to forecast the prices and arrivals of agricultural commodities and drawn conclusions. ARIMA model is an extrapolation method that requires only the historical time series data on the variable under study. The ARIMA model forecasted prices revealed an increase in the prices of cotton in the future years and also demand for the crop. Hence, increase in the area of production of cotton and their sale in the suitable markets can be planned suitably. This forecast is based on past data and model and that actual market price may not turn out to be the same as forecasted.

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