J. Cotton Res. Dev. **35**(2), 272-279 (July, 2021) **ISSN No. 0972-8619**

Measuring the price volatility and forecasting for market information system in cotton crop in Sirsa district of Haryana

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ABSTRACT: The present study was conducted in Dabwali and Baragudha blocks of Sirsa district in Haryana on the basis of maximum production under cotton crop. Further, four regulated markets in Sirsa district, *i.e.*, Dabwali, Ellenabad, Sirsa and Kalanwali markets (M1, M2, M3 and M4) were selected from Dabwali and Baragudha blocks on the basis of maximum arrival, respectively. Average prices in state data for the period of 2005 to 2016 were analyzed by time series methods. Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) were calculated for the data. Appropriate Box-Jenkins Auto Regressive Integrated Moving Average (ARIMA) model was fitted to reach the results. Validity of the model was tested by using standard statistical techniques. ARIMA (0,1,1) and ARIMA (1, 1, 3) models were also used to forecast average prices in the district for one leading years. The result also shows average prices forecast for the year 2017 to be about Rs. 3992/q with upper and lower limit of Rs. 3994 and Rs. 3992/q in M1 market, respectively. The results also shows average prices forecast for the year 2017 to be about Rs. 3939/q with upper and lower limit Rs. 3972 and Rs. 3939/q in M2 market, respectively. The results also show average prices forecast for the year 2017 to be about Rs. 3990/q with upper and lower limit Rs. 4015 and Rs. 3990/q in M4 market, respectively. The result also shows average prices forecast for the year 2017 to be about Rs. 4002/q with upper and lower limit Rs. 4049 and Rs. 4002/q in M3 market, respectively.

Keywords: ACF, ARIMA, cotton, forecasting average price, PACF

Marketing Information System as an interacting structure of people, equipments and procedures to gather sort, analyze, evaluate and distribute, timely and right information for use by proper marketing decision makers to improve their marketing design, implementation, and control (Kotler and Keller, 2012). Cotton is one of the most important fibrous crops in the world. It is also called as "White Gold". The primary product of the cotton plant has been the lint that covers the seeds within the boll. Lint is the most important economical product of cotton plant, which provides a source of high quality fibre for the textile industry. The present study was undertaken to estimate the price forecasts and long term relationship in prices among domestic markets of the specific area.

Kumar *et al.*, (2017) discussed modeling and forecasting of soybean yield in India using ARIMA analysis. Kumar *et al.*, (2019) developed a model for forecast the wheat yield in Haryana by using annual time series data from 1980-1981 to 2009-2010. They applied various methods to find out the best model to forecast the yield, *i.e.*, random walk, random walk with drift, linear trend, moving average, simple exponential smoothing and ARIMA models. Mallick and Mishra (2019) forecast interest rates of different maturities and stress points by developing univariate ARIMA models. They found that in-sample and out-of-sample performances were better forecast by using ARIMA (2, 1, 1) forecasting model of interest rates. Kumar and Verma (2020) found that ARIMA (0, 1, 1) and ARIMA (1, 1, 0) model is suitable for forecasting of mustard yield in Bhiwani and Hisar districts, respectively.

MATERIALS AND METHODS

The annual data on average prices for the period from 2005 to 2016 were used for forecasting the future values by using ARIMA models. The ARIMA methodology generally called as Box Jenkins methodology is concerned with fitting a mixed Auto Regressive Integrated Moving Average (ARIMA) model to a given set of data. The ARIMA model is fitted to identify the stochastic process of the time series and predict the future values accurately. The methods been useful in many types of situation which involve the building of models for discrete time series and dynamic systems. But this method was not good for lead times or for seasonal series with a large random component (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. However, the optimal forecast of future values of a time-series was determined by the stochastic model for that series. A stochastic process is either stationary or non-stationary. The first and important thing to note is that most time series are non-stationary and the ARIMA model refers only to a stationary time series. Since the ARIMA models refer only to a stationary time series, the first stage of Box-Jenkins model is reducing non-stationary series to a stationary series by taking first order differences. The main stages in setting up a Box-Jenkins forecasting model includes:

Identification :

Appropriate value of p,d and q are found first. The tools used for identification are the Autocorrelation Functions (ACF) and Partial Autocorrelation Functions (PACF).

The ARIMA process has the following algebraic form :

$$Y_t = C+\phi_t Y_{t-1}+\phi_2 Y_{t-2}.......+\phi_p Y_{t-p}- \theta_1 a_{t-1}- \theta 2a_{t-2}.......... \theta_q a_{t-q}+a_t$$

Where, C is a constant term related to the mean of the process. This is called a mixed auto regressive moving average model of order (p, q). It contains both AR and MA terms.

The general functional forms of ARIMA model used are :

(i) Moving Average model of order q; MA (q)

$$Y_t = C - \sum_{i=1}^{q} \theta_i a_{t-i} + a_t$$

Where, at belongs to NID (0, σ2a)

(ii) Autoregressive model of order p; AR (p)

$$Y_t = C - \sum_{j=1}^{q} \phi_i Y_{t-j} + a_t$$

(iii) Autoregressive Moving Average Model ARMA (p, q)

$$Y_t = C - \sum_{j=1}^{\rho} \phi_j Y_{t-j} - \sum_{i-1}^{q} \theta_{i at-1} + a_t$$

(iv) Autoregressive Integrated Moving Average Model ARIMA (p,d,q)

$$\phi p(B)\, \Delta^d\, Y_t = C + \theta q(nB)a_t$$

(v) Seasonal ARIMA model ARIMA (p,d,q) (P,D,Q)s

$$\phi p\,(B)\,\phi *_p\,(B^s)\Delta^d \Delta^{sD} Y_1 = \phi *_Q\,(B^S)\theta q(B)a_t$$

Where,

Y_t	=	Variable under forecasting
B	=	Lag operator
a	=	Error term (Y_t-Y_t-1, where Yt is the estimated value of Y_t)
t	=	time subscript
ϕ_p (B)	=	Non-seasonal AR
$\phi*_p$ (B^s)	=	seasonal AR operator
$(1-B)^d$	=	Non-seasonal difference
(1-Bs)d	=	seasonal difference
q_q(B)	=	Non-seasonal MA
$\phi*_p$(B^s)	=	seasonal MA operator
s	=	order of season (4 in quarterly data, 12 in monthly data etc.)

The above model contains p+q+P+Q parameters, which need to be estimated. The model is non-linear in parameters.

Estimation: For estimating the parameters of the ARIMA model, the algorithm is as follows:

For p, d, q, P, D and Q each = 0 to 2

Execute SPSS ARIMA with the set parameters.

Records the parameters and corresponding fitting error until all possible combinations are tried. Select the parameters that produce the least fitting error. This algorithm tries all combinations of parameters, which are limited to an integer lying between zero and two. The combination with the least fitting error will be searched. The range limitations of the parameters are set to restrict the searched to a reasonable scope. Parameters greater than two are rarely used in practices as per literature.

Diagnostic checking : Having chosen a particular ARIMA model and having estimated its parameters the fitness of the model is verified. One simple test is to see if the residuals estimated from the model are white noise, if not we must start with other ARIMA model. The residuals were analyzed using Box- Ljung statics.

Forecasting : One of the reasons for the popularity of the ARIMA modelling is its success in forecasting. In many cases, the forecasts obtained by this method are more reliable than those obtained from the traditional econometric models, particularly for short–term forecasts. An Autoregressive Integrated Moving Average process model is a way of describing how a time series variable is related to its own past value. Mainly an ARIMA model is used to produce the best-weighted average forecasts for single time series (Rahulamin and Razzaque, 2000). The accuracy of forecasts for both Ex-ante and Ex-post were using the following test (Markidakis and Hibbon,1979) such as Mean absolute percentage error (MAPE).

RESULTS AND DISCUSSION

In this study, the average prices used were for the period 2005 to 2016. Development of ARIMA model for any variable involves four steps i.e. Identification, Estimation, Verification and Forecasting. The explaination of these steps for cotton average prices is described as below:

MODEL IDENTIFICATION

Forecasting of cotton average price, ARIMA model estimated only after transforming the variable under forecasting into a stationary series. The stationary series is the one whose values over time only around a constant mean and constant variance. The most common method is to check stationary through examining the graph or time plot of the data is non-stationary. Non-stationary in mean is connected through appropriate differencing of the data. Under the situation difference of order 1 was sufficient to achieve stationary in mean. The newly constructed variable Xt can now be examined for stationary. The graph of Xt was stationary in mean. The succeeding steps are to identify the values of p, d and q. For this, the auto correlation and partial auto correlation coefficients of various orders of Xt are computed (Table 2). The model statistics showing goodness fit for Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), Normalized Bayesian Information Criterion (Normalized BIC), Ljung-Box statistics are depicted in Table 1. The Box-Ljung statistics of ARIMA model for cotton in M1, M2, M3 and M4 markets of the studied district are presented in Table 4.and 5and shown significant statistics. The model statistics are given in Table 2 which shows that the seasonal ARIMA models in orders of (0,1,1) (1,1,3) were found satisfactory for prices of cotton crop .

MODEL ESTIMATION AND VERIFICATION:

Cotton average prices model parameters were estimated using SPSS package. Results of estimation are reported in Table 1. The model verification is concerned with checking the residual of the model to see the systematic pattern which still can be removed to improve on the choosen ARIMA. This is done through examing the auto correlations and partial auto correlations of the residuals of various orders. The ACF and PACF of residual (Table 1) also indicate good fit of the model.

The time series plot of the residual showed a scattered trend, therefore models were fitted properly by residual analysis. The model parameters have been presented in Table 1. The

Table 1. Model statistics of different markets in Sirsa district of Haryana

Model	Dabwali market				
	Parameters	Estimated parameters	Asymptotic S.E.	Asymptotic t-value	P
Model (0,1,1) (1,1,3)	MA1	0.244	0.089	2.733	0.007
	SAR1	-0.459	0.082	-5.609	0.000
	SMA3	-0.074	0.117	-0.634	0.527
	Ellenabad market				
Model	Parameters	Estimated parameters	Asymptotic S.E.	Asymptotic t-value	p
Model (0,1,1) (1,1,3)	MA1	0.098	0.088	1.107	0.270
	SAR1	-0.339	0.088	-3.863	0.000
	SMA3	0.046	0.146	0.316	0.753
	Sirsa market				
Model	Parameters	Estimated parameters	Asymptotic S.E.	Asymptotic t-value	p
Model (0,1,1) (1,1,3)	MA1	0.240	0.087	2.759	0.007
	SAR1	-0.485	0.079	-6.150	0.000
	SMA3	-0.009	0.136	-0.069	0.945
	Kalanwali market				
Model	Parameters	Estimated parameters	Asymptotic S.E.	Asymptotic t-value	p
Model (0,1,1) (1,1,3)	MA1	0.328	0.084	3.903	0.000
	SAR1	-0.467	0.081	-5.766	0.000
	SMA3	-0.078	0.139	-0.566	0.572

results showing that there was no transformation accounted for the model fitting. It is showing that none of series was found stationary and having volatile trend. In M1, M2, M3 and M4 markets the data set only first order differentiation was found to be fit and AR(p) of Lag 1 and seasonal MA(q) of Lag 1 were fitted with the degree of differentiation. The tentative models were identified based on Autocorrelation (ACF) and Partial Autocorrelation (PACF) at fixed interval, showing significant for prices of cotton crop in selected district markets.

FORECASTING WITH ARIMA MODEL

ARIMA models are basically developed to forecast the corresponding variable. For judging the forecasting ability of the fitted ARIMA model important measure of the sample period forecasts accuracy was figure out. Forecasting performance of the model was determined by computing Mean Absolute Per cent Error (MAPE). The model with less MAPE was preferred for forecasting purposes. Forecasting was done through identified models for the variable prices of cotton crop in selected district markets. Using the obtained model, the ex-post forecasted values, considering the January, 2005 to December, 2016 were computed and have been presented in Table 6. The table observed that the forecasted price in Dabwali, Ellenabad, Sirsa and Kalanwali markets (M1, M2, M3 and M4) moved in same direction with observed values.

Price forecasts for cotton

The price forecasts in Dabwali market (M1) were observed between the ranges of Rs. 3994 to 3992/q during September to December in 2017. While, in the forecasts for the remaining months, i.e. from January to August were in the range of Rs. 4091 to 4032/q. Similarly, the price forecasts in Ellenabad market (M2) were obtained Rs. 3972 to 4719/q in September to December. While, in the forecasts for the remaining months

Table 2. Autocorrelation and partial autocorrelation functions of average monthly price in Dabwali market of Sirsa district

Lag	Autocorrelations					Partial Autocorrelations		
	Autocorrelation	Std. errora	Box-Ljung statistic Value	Df	Sig.[b]	Lag	Partial autocorrelation	Std. error
1	0.978	0.082	140.599	1	0.000	1	0.978	0.083
2	0.962	0.082	277.561	2	0.000	2	0.126	0.083
3	0.944	0.082	410.422	3	0.000	3	-0.030	0.083
4	0.924	0.082	538.508	4	0.000	4	-0.077	0.083
5	0.904	0.081	661.996	5	0.000	5	-0.016	0.083
6	0.884	0.081	780.970	6	0.000	6	-0.003	0.083
7	0.862	0.081	894.928	7	0.000	7	-0.054	0.083
8	0.840	0.080	1003.876	8	0.000	8	-0.031	0.083
9	0.816	0.080	1107.643	9	0.000	9	-0.036	0.083
10	0.797	0.080	1207.397	10	0.000	10	0.089	0.083
11	0.773	0.080	1301.875	11	0.000	11	-0.108	0.083
12	0.755	0.079	1392.636	12	0.000	12	0.097	0.083
13	0.735	0.079	1479.280	13	0.000	13	-0.028	0.083
14	0.714	0.079	1561.773	14	0.000	14	-0.021	0.083
15	0.695	0.078	1640.480	15	0.000	15	0.003	0.083
16	0.677	0.078	1715.825	16	0.000	16	0.030	0.083

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.

i.e., from January to August were in the range of Rs. 4053 to 3984/q. Therefore, the farmers need not to store their produce for future and they have to dispose-off the produce at the earlier.

The price forecasts for Kalanwali market (M4) were observed between ranges of Rs. 4015 to 3990/q in September to December for the year 2017. While, in the forecasts for the remaining months, *i.e.*, from January to August were in the range of Rs. 4084 to 4098/q. Therefore, it is advisable to the farmers to store their produce and sell in the months where they realize the higher price.

Similarly, the price forecasts for the Sirsa market (M3) were in the ranges of Rs. 4049 to 4002/q during the month of September to December in 2017. While, for the remaining months i.e. from January to August were in the range of Rs. 4086 to 3926/q. Therefore, the farmers need not to store their produce for future and they have to dispose-off the produce at the earlier.

Cointegration between selected markets for cotton agricultural commodities in selected district of Haryana (at zero order integration)

Cointegration is a statistical property obtained by given time series data set which is defined by the concepts of stationarity and the order of integration of the series. The stationary series is one with a mean value which will not change during the sampling period. For an illustration, the mean of a subset of a given series does not vary significantly from the mean of any other subset of the same series. Further, the series will constantly return to its mean value as fluctuations occur. In other words, a non-stationary series will shows a time-varying mean. The order of integration of a series is given by the number of times the series must be differenced in order to produce a stationary series. Cointegration analysis was carried out to study the long run relationship of average price of cotton for the selected districts in all four markets. The Dickey-Fuller Test was used to study the order cointegration of prices among different markets in Sirsa district.

The Table 7 revealed that Dickey-Fuller Test 'tau' was found highly significant for all the selected markets in Sirsa district. This shows that there is a long term relationship and price will remain constant over the change of time.

Table 3. Autocorrelation and partial autocorrelation functions of average monthly price in Ellenabad market of Sirsa district

Lag	Autocorrelations					Partial Autocorrelations		
	Autocorrelation	Std. errora	Box-Ljung statistic			Lag	Partial autocorrelation	Std. error
			Value	Df	Sig.[b]			
1	0.972	0.082	139.001	1	0.000	1	0.972	0.083
2	0.951	0.082	272.849	2	0.000	2	0.098	0.083
3	0.929	0.082	401.457	3	0.000	3	-0.009	0.083
4	0.907	0.082	524.957	4	0.000	4	-0.008	0.083
5	0.887	0.081	643.856	5	0.000	5	0.019	0.083
6	0.871	0.081	759.440	6	0.000	6	0.082	0.083
7	0.847	0.081	869.418	7	0.000	7	-0.154	0.083
8	0.824	0.080	974.266	8	0.000	8	-0.019	0.083
9	0.803	0.080	1074.591	9	0.000	9	0.033	0.083
10	0.780	0.080	1170.033	10	0.000	10	-0.032	0.083
11	0.755	0.080	1260.039	11	0.000	11	-0.075	0.083
12	0.734	0.079	1345.848	12	0.000	12	0.043	0.083
13	0.708	0.079	1426.268	13	0.000	13	-0.074	0.083
14	0.689	0.079	1502.938	14	0.000	14	0.097	0.083
15	0.672	0.078	1576.458	15	0.000	15	0.040	0.083
16	0.653	0.078	1646.552	16	0.000	16	-0.027	0.083

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.

CONCLUSIONS

The Box-Jenkins approach as an ARIMA model was used the patterns of the past movement of a variable to forecast the future values. The model can be used by researchers for forecasting average prices in district. In our study, the developed model for average prices for cotton in Sirsa district was found to be ARIMA (0, 1, 0) (1, 1, 3) respectively. From the forecast available by using the developed model, it can be seen that forecasted average price increases the next years. Forecasting has been computed through identified models for the variables *i.e.*, average monthly prices of cotton in selected district markets. Using the obtained models, the ex-post forecasted values, considering the January, 2005 to December, 2016 were computed and presented in Table 6 showing average monthly price of cotton crop in Sirsa district markets. It has been observed that the forecasting of average monthly prices in Dabwali, Ellenabad, Sirsa and Kalanwali markets (M1, M2, M3 and M4) were moving in scattered trend with observed values. The price forecasts in main market of selected district *i.e.*, M1 market obtained for the year 2017 for arrival season in September to December were observed between the ranges of Rs. 3994 to 3992/q. While, in the forecasts for the remaining months, *i.e.*, from January to August were in the range of Rs. 4091 to 4032/q. Similarly, the price forecasts in reference market of selected district *i.e.*, M2 market was obtained in September to December Rs. 3972 to 4719/q. While, for the remaining months, *i.e.*, from January to August were in the range of Rs. 4053 to 3984/q. Therefore, the farmers need not to store their produce for future and they have to dispose-off the produce at the earlier. The price forecasts in main market of selected district, *i.e.*, M4 market obtained for the year 2017 for arrival season in September to December were observed between the ranges of Rs. 4015 to 3990/q. While, for the remaining months *i.e.*, from January to August were in the range of Rs. 4084 to 4098/q. The price forecasts in main market of selected district *i.e.*, M3 market obtained for the year 2017 for arrival season in September to December were observed between Rs. 4002 to 4049/q. While, for the remaining months *i.e.*, from January to August were in the range of Rs. 3909 to 4086/q. Therefore, it is

Table 4. Autocorrelation and partial autocorrelation functions of average monthly price in Sirsa market of Sirsa district

Lag	Autocorrelations					Partial Autocorrelations		
	Autocorrelation	Std. errora	Box-Ljung statistic Value	Df	Sig.[b]	Lag	Partial autocorrelation	Std. error
1	0.967	0.082	137.357	1	0.000	1	0.967	0.083
2	0.945	0.082	269.683	2	0.000	2	0.169	0.083
3	0.925	0.082	397.287	3	0.000	3	.0.037	0.083
4	0.899	0.082	518.573	4	0.000	4	-0.095	0.083
5	0.877	0.081	634.789	5	0.000	5	.0.021	0.083
6	0.854	0.081	745.985	6	0.000	6	0.001	0.083
7	0.830	0.081	851.666	7	0.000	7	-0.036	0.083
8	0.809	0.080	952.814	8	0.000	8	0.023	0.083
9	0.788	0.080	1049.400	9	0.000	9	-0.001	0.083
10	0.765	0.080	1141.221	10	0.000	10	-0.022	0.083
11	0.745	0.080	1229.036	11	0.000	11	0.017	0.083
12	0.727	0.079	1313.125	12	0.000	12	0.020	0.083
13	0.703	0.079	1392.346	13	0.000	13	-0.082	0.083
14	0.684	0.079	1468.099	14	0.000	14	0.043	0.083
15	0.669	0.078	1541.078	15	0.000	15	0.062	0.083
16	0.650	0.078	1610.542	16	0.000	16	-0.029	0.083

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.

Table 5. Autocorrelation and partial autocorrelation functions of average monthly price in Kalanwali market of Sirsa district

Lag	Autocorrelations					Partial Autocorrelations		
	Autocorrelation	Std. errora	Box-Ljung statistic Value	Df	Sig.[b]	Lag	Partial autocorrelation	Std. error
1	0.975	0.082	139.797	1	0.000	1	0.975	0.083
2	0.956	0.082	275.219	2	0.000	2	0.112	0.083
3	0.938	0.082	406.333	3	0.000	3	0.007	0.083
4	0.917	0.082	532.684	4	0.000	4	-0.044	0.083
5	0.896	0.081	654.202	5	0.000	5	-0.029	0.083
6	0.877	0.081	771.246	6	0.000	6	0.008	0.083
7	0.855	0.081	883.522	7	0.000	7	-0.032	0.083
8	0.835	0.080	991.213	8	0.000	8	-0.007	0.083
9	0.814	0.080	1094.504	9	0.000	9	-0.001	0.083
10	0.796	0.080	1193.982	10	0.000	10	0.036	0.083
11	0.772	0.080	1288.285	11	0.000	11	-0.117	0.083
12	0.752	0.079	1378.466	12	0.000	12	0.041	0.083
13	0.731	0.079	1464.276	13	0.000	13	-0.027	0.083
14	0.709	0.079	1545.502	14	0.000	14	-0.036	0.083
15	0.684	0.078	1621.730	15	0.000	15	-0.069	0.083
16	0.663	0.078	1693.884	16	0.000	16	0.046	0.083

a. The underlying process assumed is independence (white noise).
b. Based on the asymptotic chi-square approximation.

advisable to the farmers to store their produce and sell in the months where they realize the better/higher price forecasts for future. The validity of the forecasted value can be checked when data for the lead periods become available. The Dickey-Fuller test suggested that the order of integration of prices among different markets selected was similar with zero suggesting that the series /prices are integrated in the long-run and therefore bear a relationship to each other thus

Table 6. Forecasting of average monthly price of cotton crop in different markets of Sirsa district

Month	Dabwali	Ellenabad	Sirsa	Kalanwali
January	4091	4053	4084	4086
February	4047	4008	4044	4022
March	4079	4024	4105	4061
April	4007	4024	4040	3909
May	4078	4022	4130	3954
June	4069	3997	4131	3958
July	4037	3987	4116	3919
August	4032	3984	4098	3926
September	3994	3972	4015	4049
October	4030	3972	4028	4032
November	4006	3951	4011	3984
December	3992	3939	3990	4002

Table 7. Cointegration between selected markets for cotton crop in Haryana

Name of district	Name of Market	Name of Crops	Dickey-Fuller test	Dickey- Fuller value	Order of integration
Sirsa	Dabwali	Cotton	-1.128	-0.836	0
	Ellenabad		-0.887	-0.836	0
	Sirsa		-1.608	-0.836	0
	Kalanwali		-1.177	-0.836	0

ratifying the law of one prices in Sirsa district. However, it should be updated from time to time with incorporation of current data. These projections may help the government to make suitable policies with regard to relative price structure, production and consumption and also to establish relations with other countries of the world.

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Received for publication : April 6, 2021
Accepted for publication : May 19, 2021