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Research Paper

Time series analysis of chilli (dry) prices in selected markets of India

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ABSTRACT : Chilli is one of the most important spice crops in India. The present study was undertaken to forecasts the prices of chilli (dry) in different markets of India using various techniques. ARIMA model (1,1,1) was identified as the best model to forecast prices in Byadagi market. According to the forecasts the price of chilli per quintal would be ranging from Rs. 6,394 to Rs. 6,546 for the months from April to July 2013. The model (1,0,1) was selected for forecasting prices of chilli in Nagpur market. The forecasts indicated that the prices of chilli per quintal would be ranging from Rs. 5,364 to Rs. 5,200 for the months from April to July 2013. The models (1,1,0) (1,1,1) were selected for forecasting prices of chilli in Virudhunagar market. The forecasts revealed that the prices of chilli per quintal would be in the range of Rs. 5,473 to Rs. 5,456 for the months commencing from April to July 2013.

KEY WORDS : ARIMA, Forecasts

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INTRODUCTION :

Chilli one of the most important commercial crops of India is known from pre historic times in Peru. It is believed to have been originated in the tropical America. Chilli occupies an important place in Indian diet. Among the spices consumed per head, dried chilli fruits constitute a major share. Currently, chillies are used throughout the world as a spice and also in the making of beverages and medicines. While consumption of chilli is the highest in India, maximum export is also from this country. Currently India is the main source of red chilli in the international market. Chilli continued to be the major item of export in the world in terms of quantity. The large demand from several chilli consuming countries is because it forms part of cuisines of various cultures and is also used as a colouring agent. Most of its demand is generated in the food processing sector. The major chilli consumers of the world are India, China, Mexico, Thailand, USA, United Kingdom, Germany and Sweden, with India again leading among the consumers (Ajjan *et al.*, 2012).

India is the global leader in the production of red chilli with a contribution of 36 per cent. Chilli produced in the country reaches various domestic destinations depending on the demand. Keeping in view the importance of chilies in world trade, it's demand in domestic and international markets, the present study was undertaken with an objective of:

– Forecasting the prices of chilli (dry) in major markets of India.

MATERIALS AND METHODS :

Time series data on monthly modal prices from 2000-01 to 2012-13 were collected in the selected markets *i.e.* Byadagi market (Karnataka), Nagpur market (Maharastra) and Virudhunagar market (Tamil Nadu). To forecast future prices ARIMA model, trend analysis, decomposition fit, moving average, single exponential smoothing, double exponential smoothing, Winter's multiplicative and ANN models were employed.

Box-jenkins model (ARIMA) :

The Box-jenkins procedure is connected with fitting a mixed auto regressive integrated moving average (ARIMA) model and is used to a given set of data. The main objective in fitting this ARIMA model is to identify the stochastic process of the time series and predict the future values accurately. These methods have also been useful in many types of situation which involve the building of models for discrete time series and dynamic systems.

The optimal forecast of future values of a time-series are determined by the stochastic model for that series. A stochastic process is stationary or non- stationary. The first thing is to note is that most time series is non-stationary and the ARIMA model refer only to a stationary time series. Therefore, it is necessary to have a distinction between the original non-stationary time series and its stationary counterpart.

Stationarity and non-stationarity :

The term stationarity meaning that the process generating the data is in equilibrium around a constant value and that the variance around the mean remains constant over time. The data must be roughly horizontal along time axis. If mean changes over time (with some trend cycle pattern) and variance is not reasonably constant then series is non –stationary in both mean and variance. If a time series is not stationary, then it can be made more nearly stationary by taking the first difference of the series. Conversely a stationary process may be summed or integrated to give a non-stationary process.

The main stages in setting up a Box-Jenkins forecasting model are as follows:

Identification of models :

A good starting point for time series analysis is a graphical plot of the data. It helps to identify the presence of trends. Before estimating the parameter (p, q) of model, the data are examined to decide about the model which best explains the data. This is done by examining the sample ACF (Auto correlation function) and PACF (Partial auto correlation function) of different series Y_t. Usually ACF and PACF are calculated upto a maximum of 24 lags (k).

Both ACF and PACF are used as the aid in the identification of appropriate models. There are several ways of determining the order type of process, but still there was not exact procedure for identifying the model.

Estimation of parameters :

After tentatively identifying the suitable model, next step is to obtain least sequence estimates of the parameters such that the error sum of squares is minimum.

There are fundamentally two ways of getting estimates for such parameters:

Trial and error:

Examine many different values and choose set of values that minimizes the sum of squares of residual.

Interative method:

Choose a preliminary estimate and let a computer program refine the estimate interatively.

The latter method is used in our analysis for estimating the parameters.

Diagnostic checking :

After having estimated the parameters of a tentatively identified ARIMA model, it is necessary to do diagnostic checking to verify that the model is adequate.

Examining ACF and PACF of residuals may show up an adequacy or in adequacy of the model. If it shows random residuals, then it indicates that the tentatively identified model was adequate. When an inadequacy is detected, the checks should give an indication of how the model need be modified, after which further fitting and checking takes place.

One of the procedures for diagnostic checking mentioned by Box-jenkins is called over fitting *i.e.*, using more parameters are necessary. But the main difficulty in the correct identification is not getting enough clues from the ACF because of inappropriate level of differencing. The residuals of ACF and PACF considered random when all their ACF were within the limits.

Forecasting :

After satisfying about the adequacy of the fitted model, it can be used for forecasting. Forecasts based on the model.

Single exponential smoothing (SES) :

Forecast requires only three pieces of data. The most recent actual, the most recent forecast and a smoothing constant. The smoothing constant (α) determines the weight given to the most recent past observations and therefore, controls the rate of smoothing or averaging.

$$F_t = \alpha Y_{t-1} + (1-\alpha) F_{t-1}$$

The current forecast equals to a weighted average of the most recent actual value and the most recent forecast value. The first actual value is chosen as the forecast for the second period.

$$F_t = F_{t-1} + \alpha (Y_{t-1} - F_{t-1})$$

It means that the current forecast is equal to the old forecast plus a fraction (α) of the error in the previous forecast, where α always lies between 0 and 1 (0.1 and 0.9). The best α should be the one to minimize the SSE or RSE. If greater weight is given to the most recent actual value, a high smoothing constant is chosen. This refers to as low smoothing. When $\alpha = 1$ provides no smoothing because the forecast equals to the most recent actual value. This refers to the zero smoothing and becomes a one period MA. That is :

$$F_t = Y_{t-1} + (1-\alpha) F_{t-1}$$

$$F_t = Y_{t-1} \quad \text{(Naive model)}$$

Derivation of exponential weight for the past actual:

$$F_t = \alpha Y_{t-1} + (1-\alpha) F_{t-1}; \qquad F_{t-1} = \alpha Y_{t-2} + (1-\alpha) F_{t-2}$$

$$F_{t-2} = \alpha Y_{t-3} + (1-\alpha) F_{t-3}; \qquad F_{t-3} = \alpha Y_{t-4} + (1-\alpha) F_{t-2}$$

After substitution

$$F_t = \alpha Y_{t-1} + (1-\alpha) [\alpha Y_{t-2} + (1-\alpha) F_{t-2}]$$

$$F_t = \alpha Y_{t-1} + (1-\alpha) \{\alpha Y_{t-2} + (1-\alpha) [\alpha Y_{t-3} + (1-\alpha) F_{t-3}]\}$$

Finally,

$$F_t = \alpha Y_{t-1} + \alpha (1-\alpha) Y_{t-2} + \alpha (1-\alpha)^2 Y_{t-3} + \alpha (1-\alpha)^3 Y_{t-4} + \ldots + (1-\alpha)^{\infty} F_{t-\infty}$$

where, $(1-\alpha)^{\infty} F_{t-\infty} = 0$

$$F_t = \alpha \sum_{S=0}^{\infty} (1-\alpha)^s Y_{t-s-1}$$

It simply states that the forecast in t^{th} period is equal to a weighted average of all past actual values and one initial forecast (closer to zero).

All weights will be summed to 1 since

$$\alpha \sum_{S=0}^{\infty} (1-\alpha)^s = \frac{\alpha}{1-\alpha} = 1$$

Brown's double exponential smoothing :

Let S' denotes a single smooth and S" denotes the double smoothed value :

$$S'_t = \alpha Y_t + (1-\alpha) S'_{t-1}$$

$$S''_t = \alpha S'_t + (1-\alpha) S''_{t-1}$$

$$a_t = S'_t + (S'_t - S''_t) = 2 S'_t - S''_t$$

where, a_t is the smoothed value of the end of period t

$$b_t = \frac{\alpha}{1-\alpha} (S'_t - S''_t)$$

where, b_t is the estimated trend of the end of the period t

Therefore, the m-period forecast is :

$$F_{t+m} = a_t + m\, b_t$$

Same as the SES, the Double smoothing estimation also requires a starting value to initialize the formulae. The common methods for estimating the starting values for Browns exponential smoothing are as follows:

Let $S'_t = S''_t = Y_1$

$a_1 = Y_1$

$$b_t = \frac{(Y_2 - Y_1) + (Y_4 - Y_3)}{2}$$

Artificial neural networks (ANN) model :

An ANN is a mathematical structure designed to mimic the information processing functions of a network of neurons in the brain. Each neuron, individually, functions in a quite simple fashion. It receives signals from other cells through connection points (synapses), averages them and if the average over a short of time is greater than a certain value, the neuron produces another signal that is passed on to other cells. It is the high degree of connectivity rather than the functional complexity of the neuron itself that gives the neuron its computational processing ability. Neural networks are very sophisticated modeling techniques, capable of modeling extremely complex functions. The neural network user gathers representative data and then invokes training algorithms to automatically learn the structure of the data.

The methodology consisted of an artificial neural network, trained with the well-known error back propagation learning algorithm, which has been successfully used in a number of forecasting applications. This is especially true in light of the fact that when we analyze a relatively small sample. Multilayer Perceptrons (MLPs) use a linear PSP function (*i.e.*, they perform a weighted sum of their inputs) and a non-linear activation function. The standard activation function (sigmoid) was used in the study. To determine the appropriate configuration of the feed-forward network, several parameters have been varied. The number of neurons in the hidden layer was determined automatically by adopting network complexity.

RESULTS AND DATA ANALYSIS :

The Box-jenkins model is concerned with fitting of mixed auto regressive integrated moving average (ARIMA) to a given set of time series data. For the present investigation ARIMA was used for predicting future prices of chillies in the selected markets and the results are presented as follows.

Chilli prices in the selected markets :

The particulars of forecasting of prices of chilli in selected markets are presented here under. ARIMA model was estimated after transforming the price data into stationary series.

Diagnostic checking:

Residual analysis was carried out to check the adequacy of the models. The residuals of ACF and PACF were obtained from the tentatively identified model. The adequacy of the model was judged by AIC and sum of the squares of residuals (Table 1). The models (111) and (1,0,1) were found to be the best for Byadagi and Nagpur markets respectively and for the Virudhunagar market the model (1,1,0) was found to be best for forecasting the chilli prices. Burark *et al.* (2013) also reported that the ARIMA model (1,1,0) possessed least AIC, SBC and MAPE values while forecasting the prices of coriander in Kota market of Rajasthan.

Table 1 : Residual analysis of monthly prices of chilli in selected markets

Market	Model	AIC	SBC
Byadagi	111	2237.82	2246.95
Virudhunagar	111	2227.67	2236.8
	110	2229.55	2235.63
Nagpur	101	1361.79	1369.49

Forecasting prices of chilli in Byadagi market :

Using the model, the forecasted prices were computed from the month of April to July 2013. The results of actual and forecasted prices are illustrated in Fig.1. It can be seen from the graph, that there was not much variation between actual and forecasted prices in Byadagi market. According to the forecasts, the price of chilli per quintal would be ranging from Rs.6,394 to Rs. 6,546 for the months from April to July 2013 (Table 2).

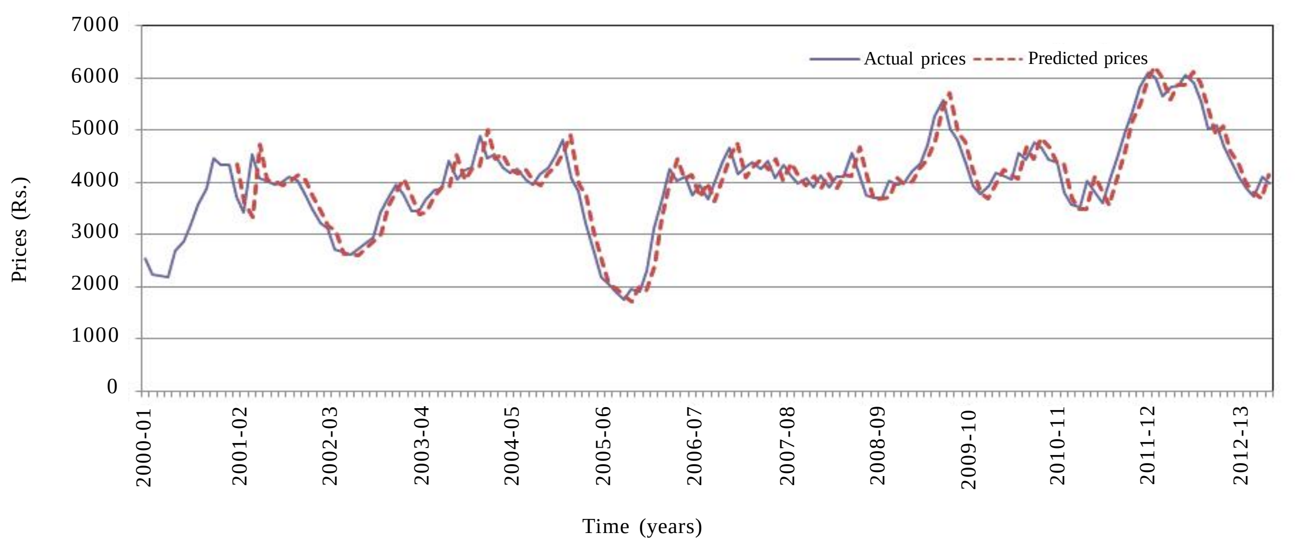

Fig. 1 : Actual and predicted (forecasted) chilli prices in Byadagi market

Table 2 : Comparison of forecasted values with real time prices for chilli in Byadagi market

Month	Real time prices	Byadagi market: Forecasted values								Deviation (%)							
		ARIMA	T.A	D.F	M.A	S.E.S	D.E.S	W.M.M	ANN	ARIMA	T.A	D.F	M.A	S.E.S	D.E.S	W.M.M	ANN
April 2013	5774	6394	4940	4763	4982	6265	6287	4799	6381	-10.74	14.45	17.52	13.72	-8.50	-8.88	16.89	-10.51
May 2013	5849	6460	4951	4542	4982	6265	6323	4600	6068	-10.45	15.35	22.34	14.83	-7.11	-8.10	21.35	-3.74
June 2013	5330	6508	4963	4550	4982	6265	6359	4547	6148	-22.10	6.89	14.63	6.53	-17.54	-19.31	14.69	-15.35
July 2013	4259	6546	4974	4680	4982	6265	6395	4732	5838	-53.70	-16.78	-9.89	-16.97	-47.10	-50.15	-11.11	-37.07

Forecasting prices of chilli in Nagpur market

The prices were predicted (forecasted) from April to July, 2013. The results of actual and forecasted prices are illustrated in Fig. 2. As is found from the graph the actual and forecasted prices of chilli in Nagpur market were more or less closer. The forecasts indicated that

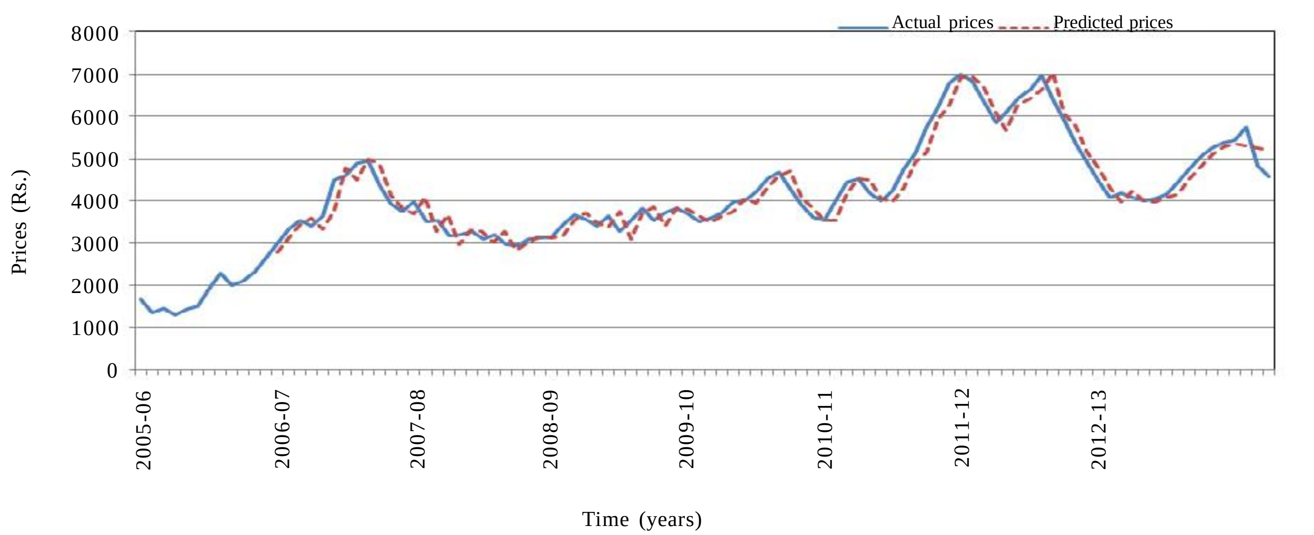

Fig. 2 : Actual and predicted (forecasted) chilli prices in Nagpur market

Table 3 : Comparison of forecasted values with real time prices for chilli in Nagpur market

Month	Real time prices	Nagpur market: Forecasted values								Deviation (%)							
		ARIMA	T.A	D.F	M.A	S.E.S	D.E.S	W.M.M	ANN	ARIMA	T.A	D.F	M.A	S.E.S	D.E.S	W.M.M	ANN
April 2013	5429	5364	5184	5013	4634	5403	5423	4062	5513	1.20	4.52	7.66	14.65	0.48	0.11	25.18	-1.55
May 2013	5750	5307	5206	4990	4634	5403	5451	3998	5231	7.70	9.46	13.23	19.41	6.03	5.20	30.47	9.03
June 2013	4833	5253	5228	5299	4634	5403	5478	4103	4767	-8.69	-8.18	-9.64	4.12	-11.79	-13.35	15.10	1.37
July 2013	4571	5200	5250	4977	4634	5403	5506	3968	4355	-13.76	-14.86	-8.88	-1.37	-18.20	-20.46	13.19	4.73

Table 4 : Comparison of forecasted values with real time prices for chilli in Virudhunagar market

Month	Real time prices	Virudhunagar market: Forecasted values								Deviation (%)							
		ARIMA	T.A	D.F	M.A	S.E.S	D.E.S	W.M.M	ANN	ARIMA	T.A	D.F	M.A	S.E.S	D.E.S	W.M.M	ANN
April 2013	5337	5473	6942	6937	5771	5470	5404	5109	5215	-2.55	-30.08	-29.98	-8.14	-2.49	-1.26	4.27	2.29
May 2013	5250	5443	6975	6595	5771	5470	5275	4758	4475	-3.68	-32.86	-25.62	-9.93	-4.19	-0.48	9.37	14.76
June 2013	6100	5445	7008	6849	5771	5470	5147	4468	4534	10.74	-14.89	-12.27	5.39	10.33	15.62	26.75	25.67
July 2013	5937	5456	7041	7025	5771	5470	5018	4156	4278	8.10	-18.60	-18.33	2.79	7.87	15.48	30.00	27.94

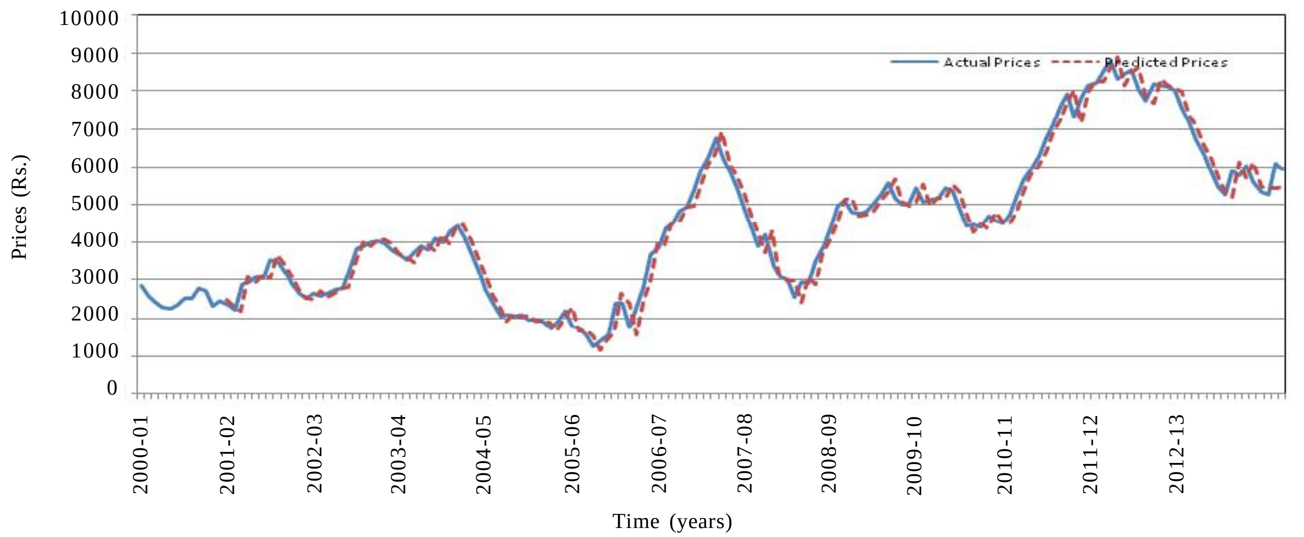

Fig. 3 : Actual and predicted (forecasted) chilli prices in Virudhunagar market

the prices of chilli per quintal will be ranging from Rs. 5,364 to Rs. 5,200 for the months from April to July 2013 (Table 3).

Forecasting prices of chilli in Virudhunagar market:

The chilli prices in Virudhunagar market were forecasted upto the month of July 2013. The results of actual and forecasted prices are illustrated in Fig. 3. It is evident from the graphical depiction that the actual and forecasted prices were more or less closer. The forecasts revealed that the prices of chilli per quintal would be in the range of Rs. 5,473 to Rs. 5,456 for the months commencing from April to July 2013 (Table 4).

Comparision of forecasted values with real time prices for chillies in selected markets :

A comparision was made between the forecasted values obtained through various models *viz.*, ARIMA, trend analysis, decomposition fit, moving average, single exponential smoothing (SES), double exponential smoothing (DES), winters multiplicative method (WMM) and ANN, with those of real time prices for chillies in selected markets in order to find out the closeness of the forecasted values of different models with real time prices.

The results obtained through trend analysis were relatively closer in respect of Byadagi market (Table 2). ANN model was better than the other models in respect of Nagpur market (Table 3) Najafi *et al.* (2007) reported that ANN had the lowest error in prediction of prices of different commodities. ARIMA was the better model with regard to Virudhunagar (Table 4).

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LITERATURE CITED :

Ajjan, N., Raveendran, N., Raghu Ram, P., Bhavani Devi, I., Srikala, M., Ranganath, P.D. and Balaji, T. (2012). Establishment and networking of agricultural market intelligence centres in India, *Commodity report (Red Chillies).*

Burark, S. S. and Sharma, Hemant and Meena, G.L. (2013). Market integration and price volatility in domestic markets of coriander in Rajasthan. *Indian J. Agril. Mktg*., **27**(1): 121-141.

Najafi, B., Zibaei, M., Sheikhi, M.H. and Tarazkar, M. H.(2007). Forecasting price of some crop products in Pars province: application of artificial neural network.[Persian]. *J. Sci. & Tech. Agric. & Nat. Res*., **11** (1b) : 501-512.

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