

## Price of cumin in Rajasthan using ARIMA approach

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### Abstract

Cumin (*Cuminum cyminum* L) is a seed spice of an annual herb. It is a native of the Levant and Upper Egypt and known to Egyptian even in 5000 BC era. Cumin is a widely used as flavouring agent in India and Middle East countries. It possesses a major role as a flavouring spice and of medicinal value throughout history. India being the world leader in spice production, it is also the largest producer of Cumin in the world. Cumin is used mainly where highly spiced foods are preferred. It is grown as a *rabi* cash crop. The crop is highly sensitive to rain. If rain occurs during harvesting time (February to March), not only production goes down (due to fungal diseases) but quality also deteriorates. Time Series data for the period of 2007-2014 were used to forecast price. The price was almost stable during the period. The price forecasting was done using Autoregressive Integrated Moving Average (ARIMA) model. The forecasted price for the period Dec 2014 to Feb 2015 was estimated to be approximately Rs10,090/Q. These projections help the farmers to decide right time to market the produce.

**Keywords:** ARIMA, cumin, forecasting, price

### Introduction

Cumin is one of the most popular spices. In India, Cumin is an important commercial crop and has several medicinal uses as remedy. Its demand is worldwide. Cumin is the largest vegetable produced and consumed not only in India but also in the world. India is a major Cumin producing country in the world with production of 394.33 lakh ton (Anonymous 1). Thus, from food, nutritional, medicinal and economic security point of view, study of price behaviour and its future prediction is of utmost importance.

India is the leading producer in the world. The country also has the largest area under cumin crop i.e. around 5.25 lakh hectares. The level of production and the total area under cumin cultivation has increased significantly during the last few years. The major districts producing cumin in Rajasthan are Barmer, Jalore, Nagore, Merta, Pali, etc.

There are wide fluctuations observed in the area under cumin crop as well as overall yield. The area under cumin crop ranges from 0.50 to 4.5 lakh hectare as well as its yield ranges from 150 to 531 kg per hectare over the years as shown in figure 1 and 2.

A fluctuation in price of cumin is shown in Figure 3. The prices vary from Rs 7000 to 13000 per quintal during the year 2000-01 to 2011-12. It may be because of the variation in yield and area. Weather condition, technological changes, etc. are also major factors

affecting the yield, area and ultimately the price of the Cumin.

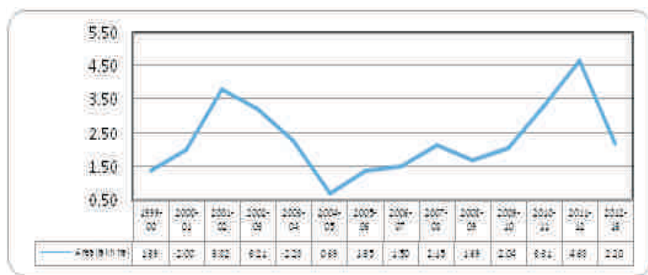
### Materials and methods

Data related to price of cumin in Merta city of Rajasthan from 2007 to 2014 were collected from Agmarknet. ARIMA modelling, introduced by Box and Jenkins, has been used to forecast pre harvest price (Burark *et. al.* 2; Chandran and Panday,3; Paul *et. al.* 4). The set of models introduced by them are popularly known as ARIMA models. This technique is used to forecast future values of a series based on completely its own past values. The main application of this methodology is in the area of short term forecasting and it requires at least 50 data points using Univariate statistics. This method is superior to other method when the data are reasonably for longer period and there is a stable correlation pattern among past observation.

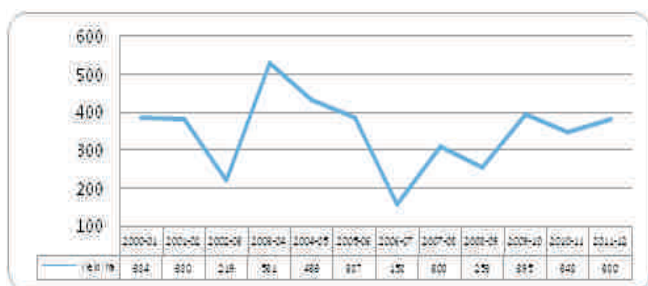
The analysis is divided into three stages:

#### Identification stage

The first step is to generate graphics and statistics of the time series. Various tests are generally performed to check the stationarity. If the series is non stationary, need to be converted into stationary series using transformations. Once a stationary series is obtained the ACF (Autocorrelation) and PACF (Partial Autocorrelation) are identified. The unique pattern of ACF's and PACF's are compared with corresponding theoretical pattern of ARIMA to identify the model.



**Fig 1:** Area of cumin crop in Rajasthan from the year 1999-00 to 2012-13



**Fig 2 :** Yield of cumin in Rajasthan from the year of 2000-01 to 2011-12

**Estimation and diagnostic checking stage**

In this stage, parameters estimation is determined. The method of least square or maximum likelihood is applied to estimate the model coefficients.

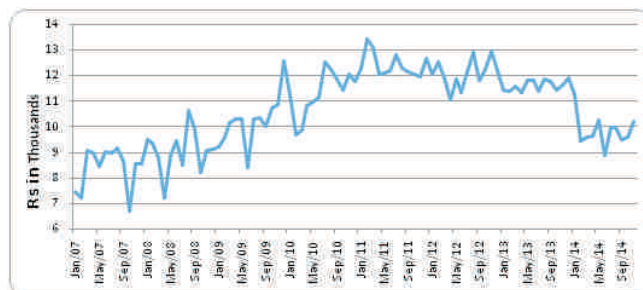
After estimating of model parameters, the adequacy of selected models is evaluated by performing statistical tests on the residue to see if they are random. Significance tests for parameter estimates indicate whether some terms in the model might be unnecessary. Goodness-of-fit statistics aid in comparing this model to others. Tests for white noise residuals indicate whether the residual series contains additional information that might be used by a more complex model. Generally Ljung-Box statistics is performed. If the diagnostic tests indicate problems with the model, researcher can try another model and then repeat the estimation and diagnostic checking stage.

**Forecasting stage**

In this stage, forecasting of the future values of the time series as well as confidence intervals are generated by using estimated ARIMA model.

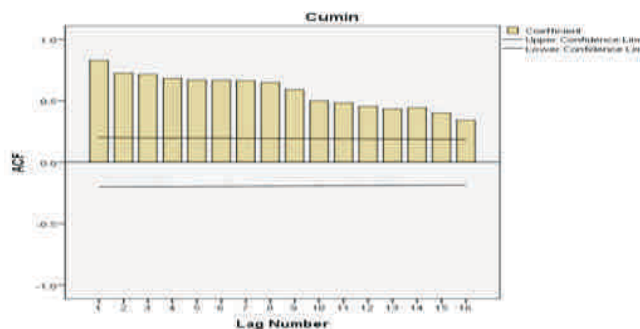
**Results and discussion**

The result of ARIMA model is presented in figure 4 and 5. It can be seen from figure 4 that ACF declined very slowly and they are significantly different form 0 and usually fell outside the 95 percent confidence level,

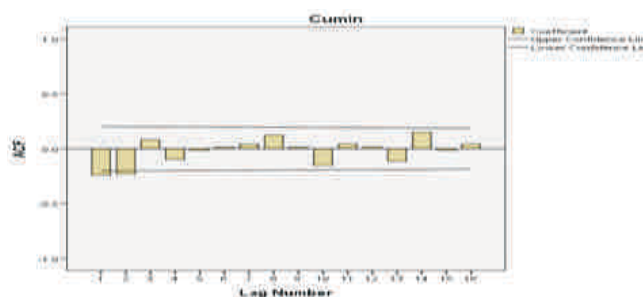


**Fig 3:** Trends in cumin price in India

which shows the price of Cumin are non stationary in nature. It is also observed from PACF as shown in Figure 5 that the series is not stationary in nature. So after converting series to stationary various ARIMA models were applied. The best fitted model i.e. ARIMA (1, 1, 1) was selected on the basis of lowest MAPE (Mean Average Percentage Error), BIC (Bayesian Information Criterion) and test of significance. The forecasted price would be Rs10090-10099 quintal in December 2014 to February 2015 as shown in the table 1. However, demand for Cumin is expected to exceed production in future and also may create severe problem of shortage in the province. Thus, it calls for an increase in the supply of cumin to fulfil the high demand of Cumin in the province. The need is to exploit the existing potential to boost Cumin production. To meet the Cumin demand in country it is needed to induce spices growers for bringing additional area under Cumin.



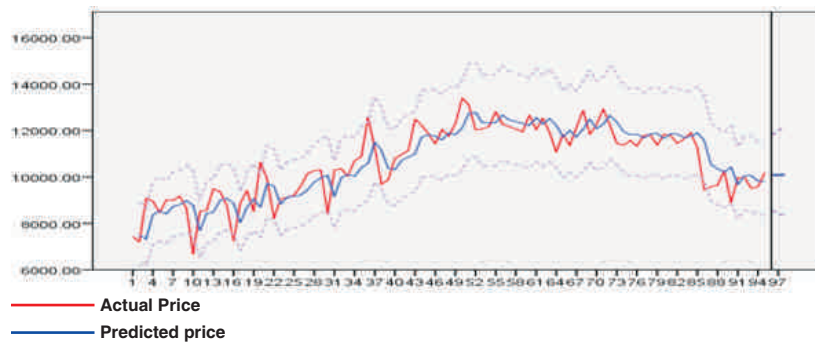
**Fig 4:** Auto Correlation Function (ACF)



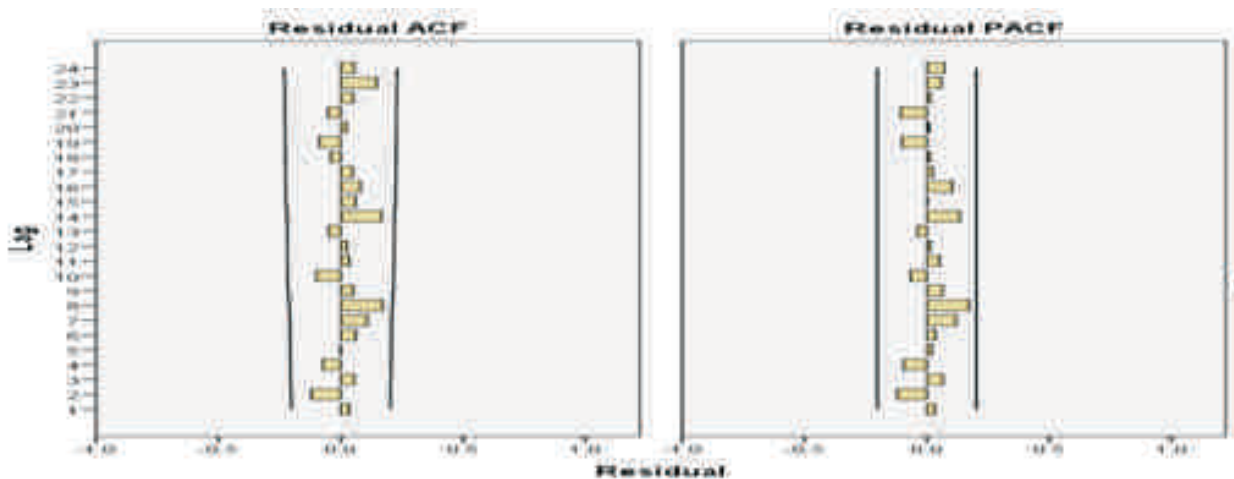
**Fig 5:** Partial Auto Correlation Function (PACF)

**Table 1:** Forecasted Price of Cumin for January and February 2015.

Model	Dec. 2014	Jan. 2015	Feb. 2015	t-value	Sig.
ARIMA MA (Moving Average)	10090.61	10081.48	10099.22	6.209	0.000



**Fig 6:** Actual and Predicted Price of Cumin



**Fig 7:** Errors of the best fit ARIMA Model

**Conclusions**

The study has revealed that the ARIMA model being stochastic in nature could be used successfully for modelling as well as for forecasting of monthly pricing of Cumin Spices in Rajasthan. The model has demonstrated a good performance in terms of predicting power. The forecast value of Cumin export during November, 2014 -December, 2014 is close to the actual values. This price forecast of cumin can help farmers as well policy makers for future planning.

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