

## Price Behaviour of Pigeon Pea in Kawardha market (*mandi*) of Chhattisgarh

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### ABSTRACT

*This study was an attempt to fulfil the requirement of regional farmers for accurate and reliable market information regarding the prices of pigeon pea in Kawardha market of Chhattisgarh. Monthly time series data of prices from April 2009 to June 2019 (123 months) was used to forecast the same for future 24 months i.e. July 2019 to June 2021. Overall trend of pigeon pea prices were found to be increasing over the study period. Seasonal indices indicate that the price is almost similar over the year but picks up a little from August to October. Seasonal ARIMA models ARIMA(2,1,1)(1,0,1)[12] was identified as best fitted model for price of pigeon pea based on lowest AIC, RMSE and MAPE and highest R<sup>2</sup> values. The fitted values of prices were found to be very close to the observed values. The data analysis is carried out using R.*

**Keywords:** ARIMA, forecast, AIC, MAPE, RMSE.

### INTRODUCTION

In Chhattisgarh pulses are second most important crops after rice. There are as many as six pulse crops viz. chickpea, pigeon pea, black/green gram, lathyrus, lentil and pea, which are grown in Chhattisgarh for human consumption. Among these pulse crops, Pigeon pea is second most important pulse crop after chickpea. As of 2017-18 pigeon pea is cultivated on 0.86 lakh hectare of land in CG. In Chhattisgarh, pigeon pea is being used in diet in many forms and the remaining amount is sold in the agricultural markets (*mandis*) for the economic fulfilment. In entire Chhattisgarh there are 69 agricultural markets

(*mandis*) but the Kawardha market have very significant edge over other markets of Chhattisgarh regarding the arrivals of pigeon pea because this market accounts for around 35% of total pigeon pea arrivals in entire Chhattisgarh.

In India's agricultural production system getting the fair price of agricultural produce has been the second greatest concern after environmental factors for the farmers. This problem of not getting the good price arises due to the failure of the agricultural marketing system and unavailability of accurate and relevant market information.

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One of the promising solutions for this concern of farmers' lies in strengthening the agricultural marketing research and market information system (Naidu & Kala 2014). Therefore prediction of reliable market information especially short run forecast of prices of agricultural commodities and proper dissemination of this information is the prerequisite for the overall development of agricultural market intelligence. Such forecasting are generally done with the time series forecasting models using the past time series data of prices of agricultural commodities.

Price fluctuations are a matter of concern among consumers, farmers and policy makers and its accurate forecast is extremely important for efficient monitoring and planning. Several attempts have been made in the past to develop price forecast models for various commodities (Ghosh & Prajneshu, 2003, Pavlista & Feuz, 2005). This study is an attempt in the same direction to fulfil this requirement of regional farmers of the proposed area i.e. Kawardha.

## MATERIALS AND METHODS

### Collection of Data

Time series data on the monthly prices of pigeon pea required for the study is collected from the records of the corresponding Agricultural Market Committees and the website of Chhattisgarh State Agricultural Marketing (Mandi) Board, <http://cg.nic.in/agrimandi/>. The data on monthly model prices in Kawardha market are collected for the study period, i.e. 2009-10 to 2019-20 (123 months).

### Analytical Methods

Moving Average method has been used to depict the overall trend of prices of pigeon pea in Kawardha market over the entire study period. Additionally it is a good idea to refine this moving average trend values to a straight line trend for a general interpretation of increase or decrease over a long period of time. For this we may fit a straight line regression equation to the moving average trend values obtained. To measure the seasonal

variation in monthly time series data of pigeon pea prices, seasonal indices are calculated by Method of Simple Averages to find out the seasonal effect.

For the forecasting of prices of pigeon pea in Kawardha market Autoregressive Integrated Moving Average (ARIMA) model is used. The similar technique was used by Darekar et al. (2016) for onion price forecasting in Kolhapur market of western Maharashtra.

### ARIMA Model

The ARIMA(p,d,q) model can be represented by the following general forecasting equation:

$$Y_t = \mu + \sum_{i=1}^p \phi_i Y_{t-i} + \sum_{j=1}^q \theta_j \varepsilon_{t-j} + \varepsilon_t$$

where  $\mu$  is the mean of series, the  $\phi_1, \dots, \phi_p$  are the parameters of the AR model, the  $\theta_1 \dots \theta_q$  are the parameters of the MA model and the  $\varepsilon_t, \varepsilon_{t-1}, \dots, \varepsilon_{t-q}$  are the noise error terms. The value of p is called the order of AR model while the value of q is called the order of the MA model (Box & Jenkins, 1976).

Since seasonal time series data is taken for this study, ARIMA model can be extended easily to handle seasonal aspects denoted as ARIMA(p,d,q)(P,D,Q)[s], where the small letter parentheses part (p,d,q) indicates the non-seasonal part of model while the capital letter part (P,D,Q)[s] indicates the seasonal part of model, s being the number of periods per season (Barathi et al., 2011).

### Model identification

A major phase in the seasonal ARIMA modelling is identifying an appropriate seasonal ARIMA(p,d,q)(P,D,Q)[s] model by examining the autocorrelation and partial autocorrelation coefficients of the time series. Since the amount of variation caused by randomness is not known at the outset, the pattern in the autos and partials is used to infer a "tentative" ARIMA(p,d,q)(P,D,Q)[s] model. First step in model identification is to make data stationary. If the series is not stationary, it must be transformed to a stationary series by taking the appropriate level of differences after that autocorrelation and partial autocorrelation is examined the number of autocorrelations or partial autocorrelations significantly different

from zero is counted. To check the stationarity in any time series data Augmented Dickey-Fuller test can be used. For a mixed ARIMA process, the AR order is determined from the partials and the MA order is determined from the autos.

**Criteria of Model Selection**

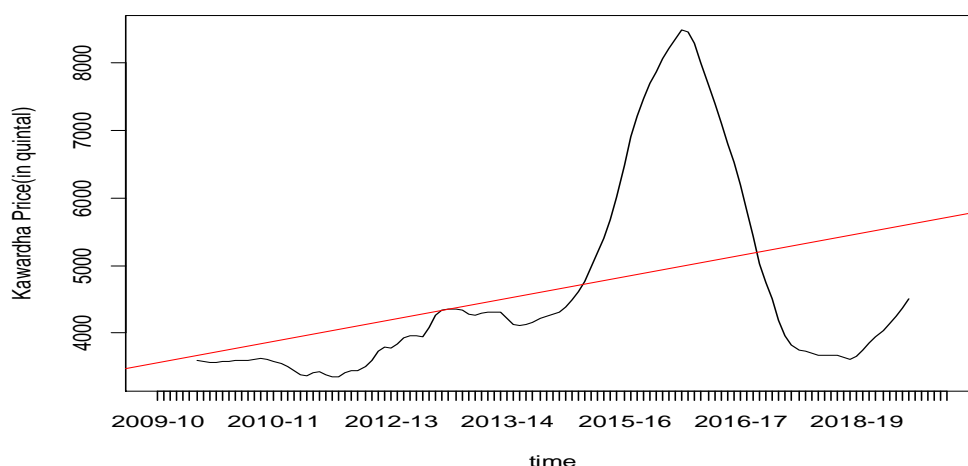
The best model for Arrivals and Prices of pulses in different markets is identified based on lowest AIC, lowest Root Mean Square Error (RMSE) and lowest Mean Absolute Percentage Error (MAPE) and highest R<sup>2</sup> criteria (Dhakre & Bhattacharya, 2014). After analysis best

model was identified; based on which the forecasting is done to forecast the prices of pigeon pea in the Kawardha market of Chhattisgarh.

**RESULTS AND DISCUSSION**

The moving average trend for price of pigeon pea in Kawardha market has been presented in Fig.1 along with the refined trend line indicated by a red line. Based on the estimated trend, it can be interpreted that there is overall increase in pigeon pea prices in Kawardha market.

**Trend of Pigeon pea Prices in Kawardha market of Chhattisgarh**



**Fig. 1: Trend of pigeon pea prices in Kawardha market of Chhattisgarh**

The seasonal indices of prices of pigeon pea in Kawardha market is presented in Table. 1 and it is observed that the price seasonal indices do not show much variation however highest

seasonal index (111.78) is observed in the month of October and lowest seasonal index (87.22) is observed in the month of December.

**Table 1: Seasonal index for pigeon pea prices in Kawardha market**

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
97.58	101.62	99.28	104.38	100.89	97.51	97.54	100.54	105.93	111.78	95.74	87.22

The monthly time series data of prices of pigeon pea in Kawardha market was analysed by above quoted method. The finally obtained best ARIMA model for pigeon price after

identification process and diagnostics checking is presented in the Table 2 and their parameter estimates are presented in Table 3.

**Table 2: Best fitted model for pigeon pea prices in Kawardha market**

Market	Model	AIC	MAPE	RMSE	R <sup>2</sup>
Kawardha	ARIMA(2,1,1)(1,0,1)[12]	1965.84	11.57243	720.4829	0.80

**Table 3: Parameter estimates of ARIMA(2,1,1)(1,0,1)[12] model**

Parameters	ar1	ar2	ma1	sar1	sma1
Coefficients:	-0.776	-0.2687	0.5646	0.6593	-0.4643
s.e.	0.2225	0.0896	0.2188	0.271	0.3181

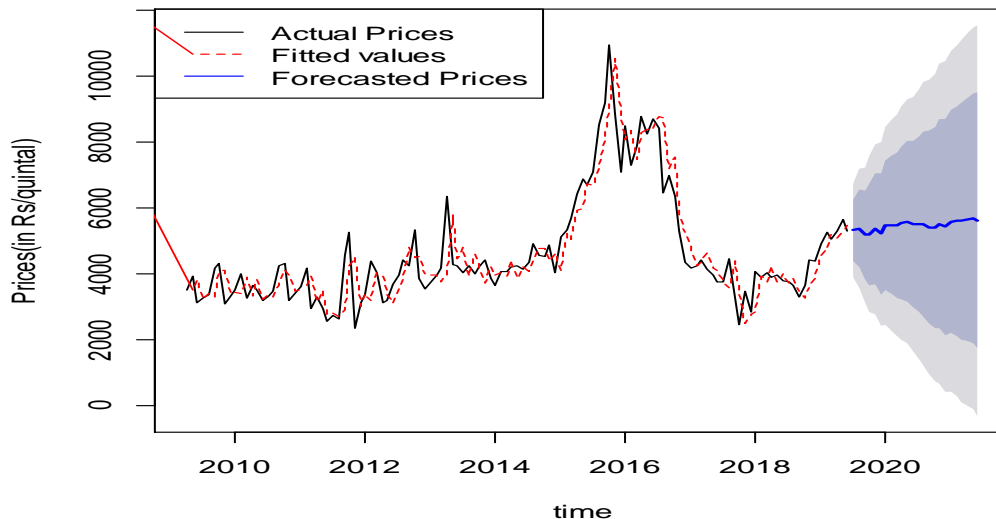
The forecasts for post sample period of 24 months i.e. July 2019 to June 2021 were made

from best fitted identified model. These forecasted values are presented in the Table 3

**Table 4: Forecasts of Prices of pigeon pea in Kawardha market**

Month	Year	Forecasted value	Year	Forecasted value
Jul	2019	5338.22	2020	5519.49
Aug	2019	5385.78	2020	5528.95
Sep	2019	5191.08	2020	5424.40
Oct	2019	5218.75	2020	5430.03
Nov	2019	5375.32	2020	5536.65
Dec	2019	5223.42	2020	5437.26
Jan	2020	5469.92	2021	5598.29
Feb	2020	5500.51	2021	5619.42
Mar	2020	5494.49	2021	5615.10
Apr	2020	5548.75	2021	5650.89
May	2020	5607.30	2021	5689.58
Jun	2020	5516.51	2021	5629.65

**Forecasts of pigeonpea Prices in Kawardha market**



**Fig. 2: Forecasts of pigeon pea prices in Kawardha market of Chhattisgarh**

As shown in the Fig. the fitted values by the model are very close to the actual values and the forecasted prices of pigeon pea in Kawardha market is showing the slight increasing behaviour over the next two years.

**CONCLUSION**

The study concluded that the seasonal ARIMA models gave good fitting for the data with

seasonality. The fitted values of prices of pigeon pea in Kawardha market are very close to their actual values. The forecasted price of pigeon pea is showing increasing trend over the next two years. The relevant forecasts of price can help both the pigeon pea farmers as well as the planners for future planning.

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