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Research Article

PRICE FORECASTING OF POTATO THROUGH SEASONAL ADJUSTED ARIMA

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Abstract: Fluctuations in prices of different agricultural commodities are a matter of concern among farmers, policy makers and stakeholders. As the potato is an extremely sensitive crop in terms of the impact of all external influences to the prices, it is imperative to study the price forecasting of potato by employing sound statistical modelling techniques that, in turn, will be beneficial to the farmers and planners in formulating suitable policies to face the challenges ahead. Seasonal adjusted ARIMA can capture the seasonal price volatility of potato.

Keywords: Price forecasting, Seasonal adjusted ARIMA

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Introduction

India is the second largest producer of vegetables after China and is a leader in the production of vegetables like peas and okra. Besides, India occupies the second position in terms of production of brinjal, cabbage, cauliflower and onion and the third position in the production of potato and tomato in the world. Amongst vegetables, potato is the most cultivated vegetable accounting for 27 per cent of the total production of vegetables in the country, followed by onion (11 per cent), tomato (10 per cent), brinjal (7 per cent), cabbage (5 per cent), cauliflower (5 per cent), peas (3 per cent) and others in the country. Netherlands (ninth in production and the highest exporter and importer) exports around 22-28 per cent of potato production. India being the third largest producer exports hardly 0.45 per cent. In India, more than 80 per cent of the potato crop is raised in the winter season (Rabi) under assured irrigation during short winter days from October to March. More than 90 per cent potato crop is grown in winter season (*Rabi*) under assured irrigation facility from October to March. The rest is being taken up during rainy season (*Kharif*). The area and production of potato in the country during 2016-17 is estimated around 20.73 lakhs ha and 486.04 lakhs MT respectively. *Kharif* potatoes are mainly grown in the states of Himachal Pradesh., Uttarakhand, Karnataka and Maharashtra states.

Price Forecasting and Market Intelligence

Fluctuations in prices of different agricultural commodities are a matter of concern among farmers, policy makers and stakeholders. For the Government, unforeseen variations in agricultural price can complicate entire planning efforts. Thus, their accurate forecasting is extremely important for efficient monitoring and planning. It is imperative to study the price forecasting of potato by employing sound statistical modelling techniques that, in turn, will be beneficial to the farmers and planners in formulating suitable policies to face the challenges ahead as the potato is extremely sensitive crops in terms of the impact of all external influences to the prices.

Research Methods

Selection of the study area

Uttar Pradesh major potato market Agra was selected on the basis of maximum arrivals and continuous availability of data.

Nature and sources of data

Keeping in view of the prices for potato have become more volatile; potato was selected purposively for the present study. Present study was based on the secondary sources. The data related to domestic prices of potato were collected from the selected Agricultural Produce Market Committees (APMCs) from year January, 2005 to May, 2018 for Agra. The secondary data on monthly price were collected from the official web site of AGMARKNET and NHRDF. To fulfil the objectives of present study, collected data were analyzed using various statistical tools seasonal adjustment, time Series analysis, ARIMA and seasonal adjusted ARIMA model. The results of the analysis are presented below to forecast the prices of potato in the Agra market. Data has been seasonally adjusted in and ARIMA model were used on seasonal adjusted prices and then multiplied by seasonal factor of that month.

Time Series Analysis

Stationary Test

The first step in the time series analysis, before testing for cointegration and Granger causality, is to examine the stationarity for each individual time series. A series is said to be stationary if the mean and variance of the series are time invariant. The ADF, PP and KPSS tests were conducted for examining the stationarity in onion price series. ADF test has been used to identify the stationarity in potato price in Agra market. [1]

Seasonal adjustment

US Census Bureau's X-12 ARIMA: The X-12-ARIMA seasonal adjustment procedure is an advanced version to estimate the seasonal component.

Assuming multiplicative model, the original time series (O_t) can be expressed in the following form.[7]

$$O_t = C_t S_t \quad \text{.....[Eq. 1]}$$

- Where Ct is the trend-cycle component,
- S_t is the seasonal component

After extreme values are identified and then modified, final estimates of the seasonal component (Seasonal factor) and seasonally adjusted series, are worked out.

ARIMA Technique

Given a time series of data X_t, the ARMA model is a tool to understand and predict the future values in series. The model consists of two parts, Autoregressive (AR) and Moving Average (MA). The model ARIMA (p, d and q) model where p, d, and q are integers, it refers to the order of the autoregressive, integration order, and moving average of the model respectively.

Given a time series of data X_t , then an ARMA (p, q) model is given by

$$(1 - \sum \varphi_i L^i) X_t = (1 + \sum \theta_i L^i) e_t \text{ .....[Eq. 2]}$$

Where,

L -lag operator,

the φ_i -Parameters of the autoregressive of the model,

the θ_i -Parameters of the moving average and the

e_t - error terms.

The error terms are assumed to be independent, identically, distributed variables sampled from a normal distribution with zero mean.

An ARIMA (p, d, q) process is obtained by integrating an ARMA (p, q) process. That is,

$$(1 - \sum \varphi_i L^i) (1 - L) X_t = (1 + \sum \theta_i L^i) e_t \text{ .....[Eq. 3]}$$

Where d is a positive integer denote the level of differencing. Note that it is only necessary to difference the AR side of the ARMA representation, because the MA component is always I (0). [3-6]

Results and Discussion

Stationary test

The hypothesis that the price series are non-stationary is tested using augmented Dickey-Fuller (ADF) test. [Table-1], The ADF test confirms the presence of unit root in the price series. But after first differencing, the series were found to be stationary in price series and therefore, integrated of order one i.e. I (1).

Table-1 Stationary test (ADF Test) for potato price series in selected markets

		At level		1st difference	
		t-Statistic	Prob.*	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.84	0.06	-10.09	0.0*
Test critical values:	1% level	-3.47		-3.47	
	5% level	-2.88		-2.88	
	10% level	-2.58		-2.58	

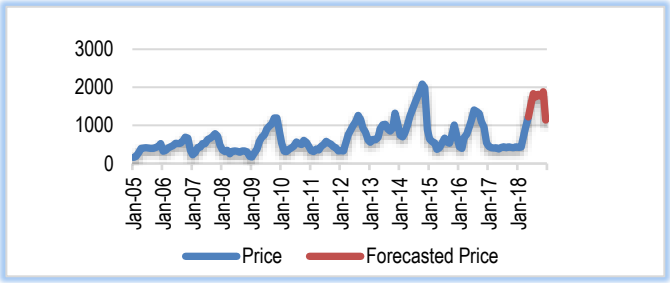

Fig-1 Price forecast of potato for Agra market (Rs./Qtl.)

(b) **Estimation of parameter**

The parameters of the identified model were estimated and presented in the [Tables-3], then the residual of the model was estimated, parameter (AR1) of ARIMA were found to be significant with lowest AIC value of 12.24.

(c) Diagnostic checking

Seasonal adjusted ARIMA (1, 1, 0) model was selected, as the best model for prices of potato in Agra market based on the significant parameter with minimum values of Akaike Information Criterion (AIC). Mean Absolute Percentage Error (MAPE) for the forecast model has been estimated 27 per cent, it means accuracy of model was 73 per cent.

(d) Forecasting of prices

Once the previous steps of ARIMA model is over, then we can obtain forecasted values by estimating appropriate model. The forecasted values obtained from ARIMA (1,1,0) model are reported in Table 4 also depicted in [Figure-1]. The forecasted values are reported for seven months. It could be seen from the Figure 1, that the forecasted values of prices of potato showed increasing trend in Agra market in the coming months and then declined in December 2018. In this market, it was observed that there were flat or constant type prices during 2017 but sudden increase in the prices was noticed after January 2018.

Table-2 Autocorrelation Functions and Partial Autocorrelation Functions

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|** |	.|** |	1	0.26	0.26	11.17	0.00
.|. |	.|. |	2	0.01	-0.07	11.18	0.00
.|. |	.|. |	3	-0.06	-0.05	11.82	0.01
.|* |	.|* |	4	0.13	0.17	14.44	0.01
.|* |	.|. |	5	0.12	0.04	16.89	0.01
*|. |	*|. |	6	-0.07	-0.13	17.72	0.01
**|. |	*|. |	7	-0.22	-0.16	26.02	0.00
*|. |	.|. |	8	-0.08	0.02	27.19	0.00
.|. |	.|. |	9	-0.01	-0.03	27.20	0.00
.|* |	.|* |	10	0.08	0.08	28.26	0.00
**|. |	**|. |	11	-0.21	-0.22	35.73	0.00
**|. |	*|. |	12	-0.27	-0.16	48.29	0.00
**|. |	*|. |	13	-0.23	-0.16	57.31	0.00
.|. |	.|. |	14	-0.01	0.01	57.32	0.00
.|. |	.|. |	15	-0.03	-0.05	57.49	0.00
*|. |	*|. |	16	-0.14	-0.09	61.05	0.00
*|. |	.|. |	17	-0.14	-0.04	64.55	0.00
.|. |	.|. |	18	-0.01	-0.06	64.56	0.00
.|* |	.|. |	19	0.11	0.01	66.84	0.00
.|* |	.|* |	20	0.19	0.11	73.19	0.00
.|* |	.|. |	21	0.08	0.07	74.34	0.00
.|. |	.|. |	22	0.06	0.01	74.92	0.00
.|. |	*|. |	23	0.03	-0.08	75.05	0.00
.|* |	.|. |	24	0.17	0.04	80.56	0.00
.|. |	*|. |	25	0.04	-0.11	80.87	0.00
*|. |	*|. |	26	-0.07	-0.08	81.93	0.00
.|. |	.|* |	27	-0.01	0.08	81.93	0.00
.|. |	.|. |	28	0.07	0.00	82.95	0.00
.|* |	.|* |	29	0.18	0.11	89.42	0.00
.|* |	.|. |	30	0.09	0.03	90.98	0.00
.|. |	.|. |	31	-0.03	0.02	91.19	0.00
*|. |	.|. |	32	-0.09	-0.07	92.85	0.00
.|. |	.|. |	33	-0.03	0.05	93.00	0.00
.|. |	.|. |	34	0.00	-0.01	93.00	0.00
**|. |	**|. |	35	-0.23	-0.24	104.34	0.00
**|. |	*|. |	36	-0.25	-0.07	117.39	0.00

Table-3 Parameter estimation for potato price in Agra

Dependent Variable: D(AGRA_SA)					
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Akaike info criterion
C	6.96	11.78	0.59	0.56	
AR(1)	0.27	0.08	3.42	0.00*	12.24

*Denote for 5 percent level of significance

Table-4 Price forecast of potato for Agra market (Rs./Qtl.)

Month	Forecasted prices (Rs./Qtl.)
Jun-18	1535
Jul-18	1838
Aug-18	1755
Sep-18	1818
Oct-18	1769
Nov-18	1885
Dec-18	1143

Conclusion and policy implication

The forecasted values of prices of potato showed an increasing trend in all

markets for June 2018 to November 2018 and declining in December 2018. Need of effective marketing intelligence tools to capture the potato volatility. As per the study Seasonal adjusted ARIMA may give better results as compared to ARIMA model for capturing the volatility because it consider the seasonal factor.

Application of research: Seasonal adjusted ARIMA can give better price forecasting for seasonally high fluctuating prices. Better econometrics model for price forecasting can help policy makers and farmers.

Research Category: Price forecasting

Abbreviations:
ARIMA: Autoregressive Integrated Moving Average
ADF: Augmented Dickey–Fuller test
PACF: Partial Autocorrelation Function
ACF: Autocorrelation Function
NHRDF: National Horticultural Research and Development Foundation

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