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Research Article

Price Stability and Co-integration Analysis of Tomato for Major Markets of Maharashtra

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ABSTRACT

The present study aimed to study price movement of tomato i.e. seasonal variation, price volatility and co-integration among the major tomato markets in Maharashtra. For study purpose the data related to monthly average prices of tomato were collected from major markets of Maharashtra State viz. Pune, Aurangabad, Nagpur and Nashik for the period 2007-2016. Moving average method was used to study seasonal variations. The econometric tools like ADF test, Johansen's Multiple Co-integration test, and ARCH-GARCH model were used to study price volatility and co-integration among selected markets. The results of the study showed that the prices of tomato were higher during the months of June to July in selected markets. The higher prices were recorded during the year 2007, 2008, 2010 and 2016. The selected tomato markets having long run equilibrium relationship for the prices of tomato and there exists co-integration among them. The volatility shocks in the prices of tomato were quite persistent in the selected markets.

Key words: *ADF test, ARCH- GARCH, Co-integration, price movement, price volatility, seasonal variation.*

INTRODUCTION

Tomato is one of the most important protective food crops of India. The area under cultivation and production in India (2015-16) is 7.74 lakh hectars and 18.73 lakh tonnes (Horticultural Statistics at a Glance 2017). The major tomato producing states are Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Telangana, Odisha and West Bengal. India is one of the largest producers of tomatoes in the world, second only to China. Around 11% of the total world produce of tomatoes is cultivated in India.

Andhra Pradesh still holds the top position in tomato production, even after creation of Telangana. Andhra Pradesh share was 18% of all India produce. Karnataka is the second largest producer of tomatoes. Recently, Madhya Pradesh has shown remarkable growth in tomato production and now occupies third position in the list of largest tomato producing states.

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In Maharashtra, tomato is grown over an area of 44.24 thousand hectares and production of 10.22 thousand MT for the year 2015-16. The markets of Tomato in Maharashtra are co-integrated and they influences on prices of each other. For better marketing of any agricultural commodity the information regarding seasonality, seasonal variations, price volatility, price movement across the state and country, etc. is necessary. Analyzing the past trend in the price of commodities is also useful in understanding the present scenario and to formulate appropriate strategies to improve the marketing system. Therefore the present study has undertaken with following specific objectives.

1) To study the seasonal variations and cyclical variations in prices of tomato.

2) To assess the price volatility and co-integration among the major tomato markets in Maharashtra.

MATERIAL AND METHODS

For the present study the data related to monthly average prices of tomato were collected for major tomato markets of Maharashtra state viz. Pune, Aurangabad, Nagpur and Nashik for the period 2007-2016 from AGMARKNET website of Government of India. Most widely used method of measuring seasonal fluctuations i.e method of moving average was used to calculate seasonal indices. The residual method of estimating cyclical movement in time series was used for estimating cyclical indices, after eliminating the seasonal variation and trend components. Before analyzing any time series data testing for stationarity is per-requisite. The stationarity of time series data of selected spot market prices of Tomato are tested by applying the Augmented Dickey-Fuller test (ADF). Johansen's Multiple Co-integration test is employed to determine the long rum relationship between the prices of selected markets of tomato. In order to know the presence of price volatility the ARCH-GARCH analysis was carried out.

RESULTS AND DISCUSSION

a) Seasonal indices for tomato prices

The mismatch between round the year consumption and seasonality in the production of crop leads to seasonal variations in prices of agricultural commodities. These variations may be purely due to seasonal production, poor storage facilities and retention power of tomato growers. The seasonal indices of monthly average prices of tomato in Pune, Aurangabad, Nagpur and Nashik markets were worked out to study seasonal variations, which are presented in Table 1.

Table 1: Seasonal indices of tomato prices for selected markets

Month	Pune	Aurangabad	Nagpur	Nashik
Jan	100.06	85.04	78.27	89.81
Feb	**62.94**	**50.13**	**45.17**	**78.94**
Mar	**68.83**	**58.57**	**47.11**	**63.68**
Apr	79.78	73.13	64.87	70.03
May	91.86	98.27	80.73	96.53
Jun	**135.70**	**178.13**	**126.01**	**159.00**
Jul	**189.88**	**180.61**	**185.87**	**167.15**
Aug	119.84	107.14	112.94	114.60

Sep	92.49	92.43	95.54	94.63
Oct	95.60	98.37	105.06	90.44
Nov	105.66	108.03	103.93	98.29
Dec	91.41	83.13	84.46	82.89

From Table 1 it is observed that in selected markets highest price indices were observed during June-July in all the markets. Prices began to decline slightly during August - October. Price indices were lowest in February-March in all markets. This is due to heavy arrivals and post harvest glut in the market. Chandrakala *et al*.[2] found that the prices of groundnut were higher in lean arrivals period.

b) Cyclical indices for tomato prices

Cyclical variations in prices were analysed in order to know the variations in prices over the years. The cyclical indices for tomato prices were worked out and are presented in Table 2.

It is observed that the cyclical variations were observed in the prices of tomato in the selected markets. The higher prices were noted in the years 2007, 2008, 2010 and 2016. The rise in prices might be attributed to less production due to bad weather and stock in the hands of middlemen.

Table 2: Cyclical indices of tomato prices for selected markets

Year	Pune	Aurangabad	Nagpur	Nashik
2007	**133.39**	**124.94**	**110.63**	**121.58**
2008	**118.21**	**116.92**	**113.69**	**102.36**
2009	70.67	92.34	71.11	99.97
2010	**114.76**	**115.54**	**164.84**	**131.78**
2011	76.43	92.59	85.78	87.64
2012	109.97	77.74	92.02	97.38
2013	76.31	91.16	79.47	95.10
2014	84.62	83.89	77.44	62.83
2015	101.23	104.77	97.91	98.55
2016	**114.42**	**100.07**	**107.08**	**102.77**

c) Stationarity in price series

Table 3 presents the results for testing the unit roots in tomato price series by Augmented Dickey-Fuller (ADF) test to check whether tomato prices are stationary in all selected markets. It is observed that at level with lag 1 the ADF value for Pune market is less than the critical value at 1 % level of significance indicated the existence of unit root which implied that the price series of Pune is stationary. The table further showed that at first order difference with lag 1 the ADF

values of Aurangabad, Nagpur and Nashik market were lower than the critical value indicated that the price series of these markets become stationary. Ghosh[5] found the prices of rice and wheat were non- stationary in levels but stationary in first order differences implied that all the series of rice and wheat prices contain a single unit root and are integrated of order one, I(1) for both the periods.

Table 3: ADF test results of tomato Prices for selected markets

Market	Level (ADF)	Critical Value (1%)	Stationary at
Pune	-8.175	-4.037	Original series
Aurangabad	-6.037		1st order
Nagpur	-8.017		1st order
Nashik	-6.734		1st order

d) Presence of price volatility

To assess the presence of price fluctuations in the prices of tomato in Pune, Aurangabad, Nagpur and Nashik markets, ARCH-GARCH analysis was carried out and the results are presented in Table4.

The sum of Alpha and Beta (á+b), indicated ARCH and GARCH effect for the given market. It was observed that among the markets, the sum of Alpha and Beta is nearer to 1 i.e. 0.96, 1.11 and 1.008 for Aurangabad, Nagpur and Nashik markets, respectively, indicated that the volatility shocks in the prices of tomato are quite persistent for a long time in these markets. Lucy Ngare, Jaquelino Massingue[8] studied analysis of price volatility in Mozambique and revealed the presence of seasonality and high volatility by using GARCH model.

Table 4: Results of ARCH-GARCH analysis of tomato prices for selected markets

Parameter	Pune	Aurangabad	Nagpur	Nashik
Alpha (á)	0.982	1.038	1.134	0.931
Beta (b)	-0.191	-0.078	-0.023	0.077
Sum of á & â	**0.791**	**0.96**	**1.111**	**1.008**

e) Market Co-integration

Johansen multiple co-integration trace test was applied for indicating the long-run relationship between the price series of selected markets. Co-integration is used instead of regular regression method because of its capacity in dealing with non-stationary series. The most popular co-integration method, developed by Johansen[7] is applied. The test shows whether the selected tomato markets are integrated or not. The results of the test were presented in Table 5.

The results of Co-integration test showed four co-integration equations were

significant at 5% level of significance which implied that there existed co-integration among the markets. Mukim *et al.*[9] found the wholesale prices of wheat were co- integrated in the long run similar results recorded by Gandhi and Koshy[4] and Ghosh[5].

Table 5: Results of multiple co-integration analysis of tomato prices for the selected markets

Hypothesized No. of CE(s)	Eigen Value	Trace Statistics	Critical Value 5%	Prob.**	No. of Co-integrating Equation CE(s)
None*	0.34732	119.4321	63.8791	0	4
At most 1*	0.225618	69.93855	42.91525	0	
At most 2	0.189127	40.27848	25.87211	0.0004	
At most 3	0.128539	15.95977	12.51798	0.0128	

CONCLUSION

In order to minimize the price risk and to protect price security of farming community for tomato crop of Maharashtra state which is very volatile commodity in terms of market prices, it is suggested that the long term procurement policy should be adopted to maintain price stability throughout the year by declaring the MSP and procurement by Nodal agencies at least for major markets of the state.

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