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Market integration and price volatility of pigeon pea in Maharashtra

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Abstract
Pigeon pea (*Cajanus cajan*) is an important pulse crop originated from India, grown in the tropical and subtropical regions of the world. Huge fluctuations in prices of farm produce were observed during past few years. The present study aimed to know Market integration of Pigeon pea prices *i.e.* seasonal variations, price volatility and co-integration among the major Pigeon pea markets in Maharashtra. For study purpose the data related to monthly average prices of pigeon pea were collected from major markets of Maharashtra state *viz.* Washim, Wardha, Mumbai and Latur for the period 2005 to 2016. Moving average method was used to study seasonal variations. The econometric tools like ADF test, Johansen's multiple co-integration test, Granger causality test and ARCH-GARCH model were used to study price volatility and co-integration among different markets. The results of study showed that the prices of Pigeon pea were higher in the months from July to October in all the selected markets. The cyclical variations observed in the prices of Pigeon pea in the selected markets. For all selected markets, the price series showed the consequences of unit root and were stationary at first order difference. The selected markets showed long run equilibrium relationship and co-integration between them. Most of the markets showed bidirectional influence on pigeon pea prices of each other. All the selected markets of study showed price volatility in Pigeon pea prices.

Keywords: Pigeon pea, market integration, price volatility, seasonal variation, adf test, arch-garch, co-integration, granger causality test

Introduction
Agriculture plays a vital role in India's economy. Over 58 per cent of the rural households depend on agriculture as their principal means of livelihood. Agriculture, along with fisheries and forestry is one of the largest contributions to the Gross Domestic Product (GDP). Being a key sector, occupying almost 17.2 per cent share of India's Gross Domestic Product (GDP) during 2017-18, the growth of agriculture and allied sector has a significant role in the overall growth of Indian economy. The planned increase in agricultural output must be coordinated with changes in the demand and supply for agricultural commodities and marketing. This can be fruitful only when the producer's share in consumer's rupee increase considerably irrespective of the volume of the marketable surplus produced with the farmers. The farmers sell their produce in the regulated markets, in accordance with the Agricultural Produce Market Act of 1939 (APMC Act, 1939).

Pigeon pea *(Cajanus cajan)* is an important pulse crop originated from India, grown in the tropical and subtropical regions of the world. Pigeon pea is grown throughout the tropical and subtropical countries especially in South Asia, Eastern and Southern Africa, Latin America, Central America and South America. The major countries producing the Pigeon pea are India, Myanmar, Malawi, Uganda, Kenya, Tanzania, Nepal, Dominica Republic, Congo, Bangladesh, Haiti, Panama etc. India is the leading producer of pulses as well as Pigeon pea in the world followed by Myanmar and Malawi. Pigeon pea is the major pulse crop contributing about 50 per cent of the total production of pulses in India. It produces about 45.99 lakh tonnes of Pigeon pea annually from about 53.87 lakh hectares of area with average productivity of 854 kg per hectare in the year 2016-17. (DES, 2016-17). The area under Pigeon pea cultivation in Maharashtra is 14.36 lakh hectares, Production 20.89 lakh tonnes and productivity 1455 kg per hectare in the year 2016-17. (State APY, 2016-17). Therefore, the present study was undertaken with the following specific objectives:

- To study the seasonal and cyclical variations in prices of Pigeon pea.
- To assess the stationarity and volatility in prices of Pigeon pea.
- To assess the co-integration and causality of price signals among selected Pigeon pea markets in Maharashtra.

Methodology

For study purpose the major pigeon pea markets from the Maharashtra State were selected *viz.,* Washim, Wardha, Mumbai and Latur. As per the records available the time series data on monthly average prices of pigeon pea for the period from 2005 to 2016 was collected from agmarknet website.

Estimation of seasonal indices of monthly data

The method of simple moving average most widely used method of measuring seasonal fluctuations and the seasonal indices were used to calculate seasonal indices.

Estimation of cyclical indices

The most commonly used method for estimating cyclical movement of time series is the residual method by eliminating the seasonal variation and trend is used to work out cyclical indices.

Testing of Stationarity in Price Series

Before analysing any time series data testing for stationarity is per-requisite. The stationarity of time series data on pigeon pea prices was tested by applying the Augmented Dickey-Fuller test (ADF). The (ADF) test is the test for the unit root in a time series sample. A stationary series is one whose parameters are independent of time, exhibiting constant mean and variance and having autocorrelations that are invariant through time. If the series is found to be non-stationary, the first order differences of the series are tested for stationarity. The number of times (d) a series is differenced to make it stationary is referred to as the order of integration, I(d).

ADF unit root test are based on the following three regression forms:

Without constant and trend $\Delta Y_t = \delta Y_{t-1} + u_t$

With constant $\Delta Y_t = \alpha + \beta T + \Delta Y_{t-1} + u_t$

With constant and trend

The hypothesis is: $H0: \delta = 0$ (Unit root)

$H_1: \delta \neq 0$

If t* > ADF critical value then accept the null hypothesis, i.e. unit root exists and

If t* < ADF critical value then reject the null hypothesis, i.e. unit root does not exists.

Presence of price volatility

To access the presence of price volatility the ARCH-GARCH analysis was carried out. Auto Regressive Conditional Heteroscedasticity (ARCH) models are specifically designed to forecast conditional variances. ARCH model introduced by Engel (1982) and generalized as GARCH by Bollersllev (1986). These models are widely used in various branches of econometrics, especially in financial time series analysis. The ARCH model has two distinct specifications one for the conditional variance and the standard GARCH (1, 1) specification is presented below:

$$Yt = \gamma_0 + \gamma_1 X_{1t} + \ldots\ldots\ldots + \gamma_k X_{kt} + e \quad \ldots\ldots\ldots\ldots 1$$

$$\sigma^2_t = \omega + \alpha e^2_{t-1} + \beta \sigma^2_{t-1} \quad \ldots\ldots\ldots\ldots 2$$

Equation (1) is the mean equation and equation (2) is the conditional variance equation. The ARCH component (α) indicate the lag of the squared residual from the mean equation and the GARCH term (β) the last period's forecast variance and the resultant sum of these co-efficient (α + β) are presented. The sum of co-efficient very close to 1 would indicate that the volatility shocks are quite persistent in the series.

Johansen's multiple co-integration test

Johansen's multiple Co-integration test is employed to determine the long rum relationship between the price series. The test shows whether the selected Pigeon pea markets are integrated or not. Johansen (1988) [2] has developed a multivariate system of equations approach, which allows for simultaneous adjustment of both or even more than two variables. The multivariate system of equations approach is more efficient than single equation approach *i.e.* it allows to estimate the co-integration vector with smaller variance. The second advantage of the multivariate approach is that in the simultaneous estimation it is not necessary to presuppose erogeneity of either of the variables.

Causality or co-movement of price signals between selected markets

The Granger causality test was applied to study the price interaction and to know the direction of causation between the selected Pigeon pea markets. It is named after the first causality tests performed by Clive Granger (1969). It analyses the extent to which the past variations of one variable explain (or precede) subsequent variations of the other. When a co-integration relationship is present for two variables, a Granger Causality Test can be used to analyze the direction of this co-movement relationship. Granger causality tests come in pairs, testing weather variable x_t Granger-causes variable y_t and vice versa. All permutations are possible:

Univariate Granger causality from x_t to y_t or from y_t to x_t,

Bivariate causality or absence of causality.

Formally, the Granger causality test analyses weather the unrestricted equation:

$$y_t = \alpha_0 + \sum T_i = 1\ \alpha_1 i\ y_{t-i} + \sum T_j = 1\ \alpha_2 i\ x_{t-j} + \varepsilon_t \text{ with } 0 \leq i, j \leq T$$

Yield better results than the restricted equation:

$$y_t = \beta_0 + \sum T_{i=} 1\ \beta_1 i\ y_{t-i} + \varepsilon_t \text{ with } \sum T_j = 1\ \alpha_2 j\ x_{t-j} = 0 \text{ (The null hypothesis)}$$

i.e. if H_0, in which $\alpha_{21=}\ \alpha_{22=}\ \ldots\ldots_=\ \alpha_2 T = 0$, is rejected then one can state "variable x_t Granger causes variable y_t"

Results and Discussion

Seasonal indices for pigeon pea prices

The seasonal indices for pigeon pea prices in Washim, Wardha, Mumbai and Latur markets are presented in table 1. From table 1 it is observed that in selected markets the prices of pigeon pea were higher during July to October months. All the markets showed lower prices in the months from November to April. During these months the arrivals starts which lowered down the prices. It is concluded that the farmers holding capacity is poor hence the traders are benefited confirming the inverse ratio between prices and arrivals. Mohd Asmatoddin *et al.* (2009) [5] the pigeon pea prices indices were highest during June to November of every year and lowest during December to May.

Table 1: Seasonal indices of Pigeon pea prices for selected markets

Month	Washim	Wardha	Mumbai	Latur
Jan	94.66	90.95	94.96	96.18
Feb	94.60	87.65	95.28	95.96
Mar	94.34	97.83	93.02	88.91
Apr	99.66	102.46	98.14	101.55
May	100.96	104.02	98.35	92.13
Jun	101.01	94.99	99.66	93.12
Jul	106.63	109.41	101.86	105.49
Aug	108.11	109.11	103.13	106.35
Sep	106.75	110.12	103.54	107.80
Oct	103.62	101.74	108.97	110.71
Nov	92.72	96.94	102.40	97.72
Dec	96.95	94.78	100.69	104.09

Cyclical indices for pigeon pea prices

From table 2 it is observed that the cyclical variations were observed in the prices of Pigeon pea in selected markets. The higher prices were noted in the year 2005, 2006, 2009, 2015 and 2016 for all the markets. Lower prices were noted in the years 2008, 2011, 2012, 2013 and 2014. The rise in prices might be attributed to less production due to bad weather and stock in the hand of middlemen.

Table 2: Cyclical indices of Pigeon pea prices for selected markets

Year	Washim	Wardha	Mumbai	Latur
2005	128.39	127.40	145.41	142.35
2006	95.48	102.42	114.29	102.16
2007	97.90	95.92	101.73	103.01
2008	94.97	93.39	96.36	90.26
2009	130.97	134.72	118.26	134.19
2010	102.79	104.01	93.15	73.97
2011	77.56	77.11	75.29	80.40
2012	79.98	83.85	67.23	82.74
2013	79.58	68.77	69.31	79.29
2014	80.64	68.19	77.47	74.75
2015	117.10	127.99	126.40	125.98
2016	114.65	116.22	115.10	110.91

Testing of stationarity in Pigeon pea price series

The Augmented Dick-Fuller (ADF) test is applied for the selected markets of study and the results are presented in table 3.

From Table 3 it was observed that at level with lag 1, the ADF values were greater than critical value at 1 per cent level of significance indicating the existence of unit root implied that the prices series in all markets were non-stationary. The table further showed that in first order difference with lag 1, the ADF values were lower than the critical value at 1 per cent level of significance and indicated that the price series were free from the consequences of unit root. This implied that the prices series were stationary at 1st difference level. Similar results were found by Patil *et al.* (2014) [6] the price series showed the consequence of unit root and were stationary at 1st order difference.

Table 3: ADF test results of Pigeon pea prices for selected markets

Market	Level (ADF)	First Difference (ADF)	Critical Value (1%)
Washim	-1.490	-5.589	-3.477
Wardha	-1.697	-13.846	
Mumbai	-1.767	-14.368	
Latur	-1.826	-17.790	

Presence of Pigeon pea price volatility

To assess the presence of price fluctuations in the prices of Pigeon pea in Washim, Wardha, Mumbai and Latur markets, ARCH-GARCH analysis was carried out and the results are presented in Table 4.

The sum of Alpha and Beta (α+β), indicated ARCH and GARCH effect for the given market. It was observed that among the markets, the sum of Alpha and Beta were nearer to 1 i.e. 1.021, 1.013, 0.999 and 1.016 for Washim, Wardha, Mumbai and Latur markets respectively, indicated that the volatility shocks in the prices of Pigeon pea are quite persistent for a long time in these markets.

Table 4: Results of ARCH-GARCH Analysis for pigeon pea prices of selected markets

Parameter	Washim	Wardha	Mumbai	Latur
Alpha (α)	0.761	0.398	0.740	0.428
Beta (β)	0.260	0.615	0.260	0.588
Sum of α & β	1.021	1.013	0.999	1.016

Market Co-integration test for Pigeon pea prices

From table 5 it was revealed that the presence of at least three co-integration equations at 5 per cent level of significance confirms that there exists long-run equilibrium relation in the prices of selected markets. The results of Co-integration test showed three co-integration equations were significant at 5% level of significance which implied that there existed co-integration among the markets. The results were recorded by Pawar *et al.* (2017) [7], found that the selected soybean markets having long run equilibrium relationship and there exist co-integration between them.

Table 5: Results of multiple co-integration analysis of selected markets

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical Value 5%	Prob.**	Number of Co-integrating Equation CE(s)
None *	0.240	88.303	47.856	0	Three
At most 1 *	0.167	49.657	29.797	0	
At most 2 *	0.144	23.868	15.495	0.002	
At most 3	0.014	1.926	3.841	0.165	
Note: Trace test indicates 3 co-integrating equations significant at the 0.05 percent level of significance.					

Causality of price signals between selected Pigeon pea markets

The results of the Granger causality test showing the relationship between selected Pigeon pea markets were presented in table 6. It was observed that there is bidirectional causality in Pigeon pea prices between Wardha and Latur, Washim and Latur, Washim and Mumbai respectively. The prices of Mumbai market exhibited unidirectional causality and affects the prices of Latur market. The prices of Mumbai market exhibited unidirectional causality and affects prices of Wardha market. The prices of Washim market exhibited unidirectional causality and affects prices of Wardha. So the influence of Washim market prices plays a significant role over the other selected markets. Thus a strong market integration of the four markets Washim, Wardha, Mumbai,

and Latur are established through the results of the analysis. Similar results were found by Lavanya (2011) [3].

Table 6: Results of Pair wise Granger Causality Test for Pigeon pea prices

Null Hypothesis:	Obs.	F-Statistic	Prob.
Mumbai does not Granger Cause Latur	142	8.317*	0.0004
Latur does not Granger Cause Mumbai		2.509	0.085
Wardha does not Granger Cause Latur	142	4.775*	0.0099
Latur does not Granger Cause Wardha		10.477*	6.00E-05
Washim does not Granger Cause Latur	142	7.136*	0.0011
Latur does not Granger Cause Washim		4.719*	0.0104
Wardha does not Granger Cause Mumbai	142	0.168	0.8453
Mumbai does not Granger Cause Wardha		18.221*	1.00E-07
Washim does not Granger Cause Mumbai	142	5.809*	0.0038
Mumbai does not Granger Cause Washim		6.255*	0.0025
Washim does not Granger Cause Wardha	142	21.261*	9.00E-09
Wardha does not Granger Cause Washim		2.895	0.0587

Note: * denotes significant at 1 % level of significance.

Conclusion

The study examined the market integration of Pigeon pea across the major markets in major pigeon pea producing districts of Maharashtra. In selected markets the price of Pigeon pea was higher from the month of July to October in all selected markets. The cyclical variation was observed in the prices of Pigeon pea higher prices was observed during the years 2005, 2006, 2009, 2015 and 2016 in the selected markets. The price series of all selected pigeon pea markets were non - stationary at level with lag 1 and all markets became stationary after 1st order difference. The results of ARCH-GARCH analysis showed that volatility shocks were persistent in the selected markets of pigeon pea in Maharashtra. The selected markets having long-run equilibrium relationship for the prices of selected pigeon pea and there exists co-integration among them as indicated by the results of Johansen's multiple co-integration test. The prices were bi-directional causality observed in Pigeon pea prices between Wardha and Latur, Washim and Latur, Washim and Mumbai respectively. The prices of Mumbai market exhibited unidirectional causality and affects the prices of Latur market.

References

1. Bollersler T. Generalized Autoregressive Conditional Heteroscedasticity. Journal of Econometrics. 1986; 31:307-327.
2. Johansen S. Statistical Analysis of Cointegration Vectors. Journal of Economic Dynamics and Control. 1988; 12:231-254.
3. Lavanya M. Price behaviour and marketing practices of turmeric in erode district of Tamil Nadu. M.Sc. Thesis, TNAU, Coimbatore, India, 2011.
4. Lucy Nagare, Franklin Simotve, Jacqueline Mashingual. Analysis of price variability and implications for price stabilization policies in Mozambique, Journal of Busi. & Manag. 2014; 6(22):160-173.
5. Mohd Asmatoddin, Satpute TG, Maske VS. Arrival and price behaviour of important pulse crops in Parbhani district. Int. Jr. of Agri. Sci. 2009; 5(2):428-430.
6. Patil VK, Tingre AS, Chaudhari DJ. Red gram price movement across major markets of Maharashtra. Int. Res. J Agril. Econ. & Stat. 2014; 5(1):70-75.
7. Pawar P, Tingre AS, Deshmukh RG, Kolhe RK. Analysis of price stability of soybean for Amravati division of Maharashtra. Maharashtra Jr. of Agril. Econ. 2017; 19(1):9-12.