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Research Paper

Soybean price movement across major markets of Madhya Pradesh

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ABSTRACT : Soybean is the leading oilseed produced globally. Huge fluctuations in prices of farm produce are observed during past few years. The present study aimed to study price movement of soybean *i.e.* seasonal variation, price volatility and co-integration among the major soybean markets in Madhya Pradesh. For study purpose the data related to monthly average prices and arrivals of soybean were collected from major markets from different markets in States *viz.*, Betul, Dewas, Dhar and Indore for the period 2005-2016. Moving average method used to study seasonal variation. The econometric tools like ADF test, Johansen's Multiple Co-integration test, Granger Causality Test and ARCH-GARCH model were used to arrive at conclusion. The results of study showed that the prices of soybean were higher in the months from June to August in all selected markets. The cyclical variation observed in the prices of soybean in the selected markets. For all selected markets the prices series are free from the consequences of unit root and were stationary at first difference. The selected markets show long run equilibrium relationship and co-integration between them. Most of the markets showed bidirectional influence on soybean prices of each other. Betul, Dewas, Dhar, and Indore, recorded low price volatility in soybean prices.

KEY WORDS : ADF test, ARCH- GARCH, Co-integration, Granger causality test, Price movement, Price volatility, Seasonal variation, Soybean

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INTRODUCTION :

The soybean (*Glycine max* L.) is a species of legume, popularly known as the "GOLDEN BEAN" or "MIRACLE BEAN" of the 21st century. The plant is classed as an oilseed rather than a pulse. Soybean is an important source of high quality but inexpensive protein and oil. Soybean is the leading oilseed produced globally. Although, a native of China, soybean for all practical reasons is an American crop today. USA is the major producer of soybean and ranks first in production. Its share in the world production is almost 35 per cent. Brazil, Argentina and China rank second, third and fourth position in terms of production, respectively. India occupies fifth place (*www.agmarknet.nic.in*).

In the recent past, Soybean cultivation has increased many folds as compared to any other oil seed crop in the country and stands next to groundnut, though commercial production of soybean began in 1971-72. Madhya Pradesh, Maharashtra and Rajasthan accounted for 56 per cent, 30 per cent and 10 per cent production, respectively during the year 2002-03 covering an area of

56 per cent, 30 per cent and 8 per cent in India (GoI, 2015).

Soybean is fastest growing crop in India which replaced the crops like Maize, Cotton and Pulses. Huge fluctuations in prices of farm produce are observed during past few years. The major factors influencing on prices of soybean are the arrivals in market, climatic conditions during the various growth stages, carry forward stocks, price movement over the period of time, crop condition through out the country, export and import, global and domestic demand and supply, etc. Seasonal variations observed in prices of soybean. In the peak arrivals months the prices of soybean declined while in lean period they rises. The markets of Soybean in Madhya Pradesh 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. The study of seasonal variations is considered to be important as a guide to the producer to market his products and to the consumer to purchase his needs at the right time. It also serves as a guide to the Government to operate its policy measures (procurement and buffer release) at the appropriate time. The knowledge of cyclical variation help us in the insulating the economy against violent fluctuations. Therefore the present study has undertaken with following specific objectives.

– To study seasonal variations and cyclical variations in prices of soybean.

– To assess the price volatility and co-integration among the major Soybean markets in Madhya Pradesh.

MATERIALS AND METHODS :

For study purpose, the major soybean markets from the states were selected *viz.,* Betul, Dewas, Dhar, and Indore. As per the records available the time series data on monthly average prices and arrivals of soybean for the period from 2005 to 2015 was collected from official website of AGMARKNET for respective market.

Method of moving average :

The method of moving average most widely used method of measuring seasonal fluctuations and the seasonal indices were obtained with following steps.

– Twelve month centered moving average value for given market arrivals and prices data were obtained.

– The original value as a percentage of centered moving average values for all months were expressed, except for first six month and six month at the end.

– These percentage were arranged according to the years and month. Primarily seasonal indices were obtained on eliminating the irregular component by averaging these percentages for each month. The average was taken over different year.

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. This is accomplished by dividing (Yt) by corresponding (S) for time ‘t’. Symbolically,

$$\text{T.C.I.} \ Z \ \frac{\text{T.C.S.I}}{\text{S}}$$

Further, cyclical movements along with irregular flucatuions are calculated by detrending. Symbolically,

$$\text{C.I.} \ Z \ \frac{\text{T.C.I}}{\text{T}}$$

Augmented dickey-fuller test (ADF) :

Before analyzing any time series data testing for stationarity is per-requisite. First the test for stationarity of time series data on Soybean prices is conducted. An Augmented Dickey-Fuller test (ADF) 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. It the series is found to be non-stationary, the first 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

$\Delta Yt = \alpha + \beta T + \delta Y_{t-1} + ut$

With constant and trend

the hypothesis is : H_0: □ = 0 (Unit root)

H_0: □ ≠ 0

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

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

Johansen's multiple co-integration tests :

Johansen's multiple co-integration test is employed to determine the long rum relationship between the price series. The test shows whether the selected Soybean markets are integrated or not. Johansen (1988) 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.

Granger causality tests :

In order to know the direction of causation between the markets Granger Causality test was employed. When a co-integration relationship is present for two variables, a Granger Causality Test (Granger, 1969) can be used to analysis the direction of this co-movement relationship. Granger causality tests come in pairs, testing weather variable xt Granger-causes variable yt and *vice versa*. All permutations are possible: univariate Granger causality from xt to yt or from yt to xt, bivariate causality or absence of causality. Formally, the Granger causality test analyses weather the unrestricted equation

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

Yield better results than the restricted equation.

$Yt = \beta 0 + \Sigma T_i = 1\ \beta_1 i\ y_{t-i} + \varepsilon_t$ with $\Sigma T_j = 1\ \alpha_2 j\ x_{t-j} = 0$ (The Null hypothesis) *i.e.* if H0, 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".

ARCH-GARCH model :

To access the presence of price volatility the ARCH-GARCH analysis carried out. Autoregressive Conditional Heteroscedastcity (ARCH) models are specifically designed to model and forecast conditional variances. ARCH model introduced by Engle (1982) and generalized as GARCH by Bollerslev (1986). The ARCH model have two distinct specifications one for the conditional variance and the standerd GARCH (1,1) specification is presented below.

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

$$\sigma^2_t = \omega + \Sigma e^2_{t-1} + \beta\ \alpha^2_{t-1} \qquad (2)$$

Equ. (1) is the mean equation and equ. (2) is the conditional variance equation. The ARCH component (☐) 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 (☐ + β) are presented. The sum of co-efficient very close to 1 would indicate that the volatility shocks are quite persistent in the series.

Vector error correction model :

Even if one demonstrates market integration through cointegration, there should be disequilibrium in the short run *i.e.* price adjustment across markets may not happen instantaneously. It may take some time for the spatial price adjustments. Error correction model can incorporate such short-run and long-run changes in price movement. A generalized ECM formulation to understand both the short-run and long-run behaviour of prices can be considered by first taking taking the autoregressive distributed lag (ADL). The generalized form of this equation for k lags and an intercept term is as follows.

$\Delta Yt = a00 + \Sigma\ ai1\Delta Xt\text{-}1 + m0[m1Xt\text{-}k - Yt\text{-}k] + \varepsilon t$

where $m0 = (1 - \Sigma ai2)$

The parameter m0 measures the rate of adjustment of the short-run deviations towards the long run equilibrium. Theoretically, this parameter lies between 0 and 1. the value 0 denotes no adjustment and 1 indicate an instantaneous adjustment. A value between 0 and 1 indicate that any deviations will have gradual adjustment to the long-run equilibrium values.

RESULTS AND DATA ANALYSIS :

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Seasonal variation :

The arrivals of soybean start hitting in the market from the month of October and continue for next five months. The peak period of arrivals is October to March. Due to large arrivals during this period the prices decline. The lean period is from June to September. The prices were recorded higher from April to August. Most of the traders release the stored stock of Soybean during this period in anticipation of making the profit. The seasonal indices of monthly average prices of soybean in Betul, Dewas, Dhar, and Indore markets were worked out to study seasonal variations, which are presented in Table 1.

From Table 1 it is observed that in selected markets the prices were higher from May to August. The prices of soybean recorded highest by 12.48, 8.52 and 7.92 per cent during May in the Betul, Dhar and Indore markets, respectively. The prices of soybean recorded highest by 18.33 per cent during December in the Dewas market. Betul, Dhar and Indore markets recorded lower prices in the months from October to February. The lowest prices recorded by 84.58, 91.41, and 92.25 in the month of November in Betul, Dewas, and Dhar market, respectively. Lowest prices recorded by 94.02 in the month of October in Indore market. During these months the arrivals starts which lowered down the prices. Chandrakala (2009) found that the prices of ground nut were higher in lean arrivals period

Cyclical variation

The cyclical indices were worked out for the period 2005-2016 and presented in Table 2.

The cyclical variation observed in the prices of soybean in the selected markets. The higher prices recorded during the year 2005, 2013, 2014 and 2015. It was observed that at the start of decade during the year 2005 the prices of soybean was higher by 51.92, 37.16, 53.89 and 46.78 per cent in Betul, Dewas, Dhar, and Indore market, respectively. During the year 2012 by 12.03, 11.49, 10.40 and 11.33 per cent in Betul, Dewas,

Table 1 : Seasonal index for soybean prices and arrivals in different markets of Madhya Pradesh

Months	Betul		Dewas		Dhar		Indore	
	Prices	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices	Arrivals
Jan	95.93	133.52	94.05	71.84	95.57	120.62	96.71	102.20
Feb	95.91	83.19	94.67	88.35	96.88	57.91	97.21	61.70
Mar	99.47	103.37	95.49	102.66	99.10	41.86	100.54	41.35
Apr	107.58	175.07	102.00	63.16	105.82	53.37	104.25	38.08
May	112.48	92.53	107.38	64.26	108.52	66.95	107.92	63.33
Jun	107.67	43.86	103.25	49.69	105.15	63.79	104.65	66.51
Jul	107.36	81.16	104.66	66.55	107.07	82.11	103.04	100.01
Aug	105.85	52.30	104.06	54.02	106.20	62.50	102.04	44.75
Sep	100.09	44.86	94.37	67.77	96.17	70.89	97.72	88.78
Oct	95.84	84.70	90.32	261.70	92.96	155.83	94.02	224.53
Nov	84.58	163.69	91.41	194.75	92.25	300.61	94.29	220.55
Dec	87.23	141.75	118.33	115.25	94.32	123.55	97.62	148.22

Table 2 : Cyclical index for soybean prices in different markets of Madhya Pradesh

Years	Betul	Dewas	Dhar	Indore
2005	151.92	137.16	153.89	146.78
2006	93.02	85.80	95.84	97.24
2007	79.24	78.19	81.63	78.96
2008	88.23	115.83	87.83	93.89
2009	106.37	104.64	105.29	106.31
2010	103.42	102.33	100.14	101.91
2011	84.39	81.10	81.70	81.08
2012	83.73	84.77	83.64	82.44
2013	112.03	111.49	110.40	111.33
2014	112.39	111.62	111.68	111.45
2015	107.02	109.06	109.82	110.32
2016	78.25	78.01	78.15	78.29

Dhar, and Indore market, respectively. The rise in prices attributed to less production due to bad weather conditions. The soybean prices rose again by 12.39, 11.62, 11.68 and 11.45 during the year 2014 in Betul, Dewas, Dhar, and Indore market, respectively (Chandrakala, 2009).

Augmented dickey-fuller test (ADF) :

The Augmented Dickey Fuller (ADF) based unit root test procedure is done to check weather soybean prices are stationary in the markets under study.

From Table 3 it is observed that at level with lag 1, the ADF values are more than critical values at 1 per cent level of significance indicating the existence of unit root implied that the prices series in all markets are non-stationary. This implied that the soybean prices series are non-stationary at level. The table further showed that in first difference with lag 1, the ADF values are lower than the critical values at 1 per cent level indicated that the prices series are free from the consequences of unit root. This implied that the prices series are stationary at 1st difference level. Ghosh (2011) found the prices rice and wheat were non-stationary in levels but stationary in first-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 period

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 soybean markets are integrated or not. The results of the test presented in Table 4.

To test whether the selected soybean markets are integrated or not, Johanson multiple co-integration test

Table 3 : ADF test results of soybean prices

Markets	Level	First difference	Critical value (1%)
Betul	-3.078647	-9.678906	-4.019561
Dewas	-3.543211	-13.62513	
Dhar	-3.230115	-9.758770	
Indore	-3.829888	-9.744279	

Table 4 : Results of multiple co-integration analysis

Domestic soybean market	Eigen value	Trace statistics value (5%)	Critical No. of CE (s)	Hypothesized	No. of co-integration equation
Indore	0.348942	115.9689	55.24578	None *	Four
	0.151333	52.02465	35.01090	At most 1 *	
	0.110644	27.57543	18.39771	At most 2 *	
	0.065564	10.10399	3.841466	At most 3 *	

Trace test indicates 4 co-integrating eqn(s) at the 0.05 level
* Denotes rejection of the hypothesis at the 0.05 level

Table 5 : Results of pair-wise granger causality test

Null hypothesis	Obs	F-Statistics	Prob.
DEWAS does not Granger Cause BETUL	152	0.22620	0.7978
BETUL does not Granger Cause DEWAS		23.3356	2.E-09
DHAR does not Granger Cause BETUL	152	8.86142	0.0002
BETUL does not Granger Cause DHAR		1.92224	0.1499
INDORE does not Granger Cause BETUL	152	14.8555	1.E-06
BETUL does not Granger Cause INDORE		2.29146	0.1047
DHAR does not Granger Cause DEWAS	152	29.0956	2.E-11
DEWAS does not Granger Cause DHAR		0.52105	0.5950
INDORE does not Granger Cause DEWAS	152	31.5361	4.E-12
DEWAS does not Granger Cause INDORE		0.34436	0.7092
INDORE does not Granger Cause DHAR	152	9.72843	0.0001
DHAR does not Granger Cause INDORE		2.88401	0.0591

Sample: 2003M01 2015M10 Lags: 2

conducted by using E-views software and the results presented in Table 4. The results of co-integration test showed at least four co-integration equations at 5 per cent level of significance indicated that the selected soybean markets having long run equilibrium relationship and there exists co-integration between them. Mukim *et al.* (2009) found the wholesale prices of wheat were co-integrated in the long run. Similar results recorded by Gandhi and Koshy (2006) and Ghosh (2011).

Granger causality tests :

In order to know the direction of causation between

Table 6 : Results of ARCH-GARCH analysis

Parameter	Betul	Dewas	Dhar	Indore
Alpha (α)	1.132258	1.036139	1.152858	1.132628
Beta (β)	-0.820284	-0.012270	-0.852293	-0.828658
Sum of α and β	0.311974	1.023869	0.300565	0.30397

Table 7 : Results of vector error correction model

Error correction	D (BETUL)	D (DEWAS)	D (DHAR)	D (INDORE)
Coint Eq1	-0.059031	-0.577803	-0.028276	0.060048
	(0.02736)	(0.07685)	(0.02688)	(0.02926)
	[-2.15753]	[-7.51840]	[-1.05180]	[2.05228]
D (AKL(-1))	-0.036723	0.123452	0.399524	0.153900
	(0.13735)	(0.38580)	(0.13495)	(0.14688)
	[-0.26737]	[0.31999]	[2.96044]	[1.04779]
D (AKL(-2))	-0.039616	0.259129	0.165122	0.007878
	(0.13471)	(0.37840)	(0.13237)	(0.14406)
	[-0.29407]	[0.68481]	[1.24747]	[0.05468]
D (WASHIM(-1))	0.056005	-0.083984	0.030313	-0.072652
	(0.03624)	(0.10179)	(0.03561)	(0.03875)
	[1.54540]	[-0.82505]	[0.85129]	[-1.87467]
D (WASHIM(-2))	0.020786	-0.049162	0.005885	-0.052636
	(0.02790)	(0.07838)	(0.02742)	(0.02984)
	[0.74495]	[-0.62726]	[0.21465]	[-1.76395]
D (LATUR(-1))	0.395764	1.050774	-0.107019	0.029806
	(0.14747)	(0.41422)	(0.14490)	(0.15770)
	[2.68371]	[2.53675]	[-0.73858]	[0.18900]
D (LATUR(-2))	-0.307197	0.654410	-0.626367	-0.262936
	(0.15376)	(0.43189)	(0.15108)	(0.16443)
	[-1.99790]	[1.51522]	[-4.14595]	[-1.59907]
D (NAGPUR(-1))	-0.025206	-0.898083	0.030944	0.226066
	(0.11170)	(0.31375)	(0.10975)	(0.11945)
	[-0.22566]	[-2.86240]	[0.28195]	[1.89252]
D (NAGPUR(-2))	0.123289	-1.395828	0.235212	-0.016854
	(0.11094)	(0.31161)	(0.10900)	(0.11864)
	[1.11133]	[-4.47943]	[2.15784]	[-0.14206]
C	13.82644	19.08230	13.22070	14.17982
	(15.6223)	(43.8811)	(15.3500)	(16.7065)
	[0.88504]	[0.43486]	[0.86128]	[0.84876]
R-squared	0.237121	0.521231	0.232887	0.137687
Adj. R-squared	0.188426	0.490671	0.183922	0.082645
AIC	13.40930	15.47487	13.37413	13.54349
SBC	13.60912	15.67469	13.57395	13.74331

Note: Standard errors in ( ) and t-statistics in [ ].

the markets Granger Causality test was employed. When a co-integration relationship is present for two variables, a Granger Causality Test (Granger, 1969) can be used to analysis the direction of this co-movement relationship. Theoretically, a variable is said to Granger-cause another variable, if the current value is conditional on the past value.

The casual relationship between the price series of selected soybean markets where approached through Granger Causality technique. The results of the analysis showing the relationship between selected soybean markets are presented in Table 5. Dewas and Betul market exhibited unidirectional causality and prices of Betul market affected Dewas market. Dhar and Betul market showed bidirectional causality Similarly Indore and Dewas market. So the influence of Betul prices played a significant role over the other market prices and the influence is so strong that F- Stat. values happened to be significant at 1 per cent level. Thus a strong market integration of the four markets, Betul, Dewas, Dhar, and Indore are established through the results of the analysis. Similar results found by Ajjan *et al.* (2009).

Price volatility:

To assess the presence of price fluctuations in the prices of Soybean in Betul, Dewas, Dhar, and Indore market ARCH-GARCH analysis is carried out and presented in Table 6.

It was observed that among the markets, the sum of Alpha and Beta is not nearer to 1 *i.e.* 0.311974, 0.300565, and 0.30397 for Betul, Dhar, and Indore markets, respectively, indicated that the absence of price fluctuations in soybean prices and sum of Alpha and Beta is nearer to 1 *i.e.* 1.023869 for Dewas market indicated that the price fluctuations in Soybean prices during the study period.

Vector error correction model :

Since the Johansen's multiple co-integration test result showed that the selected soybean market having long run equilibrium relationship and there exists co-integration between them. Hence, the vector error correction model (VECM) is employed to know the speed of adjustments among the soybean markets for long run equilibrium. The results of VECM showed in Table 7.

The estimates of vector error correction model revealed that Betul, Dewas, Dhar, and Indore markets came to equilibrium in long run. Betul market one month's lag price is affecting current prices of Dhar market. Dhar market one month lag price is affecting current prices of Betul and Dewas. Dhar market two months lag prices is affecting current of their own market. Indore market one month's lag prices is affecting current prices of Dewas market. Indore market two months lag pieces is affecting current prices of Dewas and Dhar market. Betul, Dewas and Indore markets attain short run equilibrium rapidly.

Conclusion :

The study examined the price movement of soybean across the major markets in major soybean producing districts of Madhya Pradesh. In selected markets the soybean prices were higher from May to August. The cyclical variation observed in the prices of soybean in the selected markets. The higher prices of soybean recorded during the year 2005, 2013, 2014 and 2015. The results of ADF test showed that all the markets having the ADF values lower than the critical values at 1 per cent level indicated that the price series are stationary at first difference level. The analysis of multiple co-integration depicted that the selected markets having long run equilibrium relationship and their exist co-integration between them. There was bidirectional influences on soybean prices of Dhar and Betul, Indore and Dewas and the influence of Betul prices played a significant role over the other market prices. As the sum of Alpha and Beta worked out is not nearer to 1 for Betul, Dhar and Indore market, this indicated low price volatility in Soybean prices in these markets.

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