International Journal of Agriculture and Food Science 2025; 7(9): 221-227

ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(9): 221-227
www.agriculturaljournals.com
Received: 25-06-2025
Accepted: 27-07-2025

Pratik D Gaikwad
M.Sc. Scholar, Department of Agricultural Economics, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Sachin S More
Professor and Head, Department of Agricultural Economics, CoA, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Digambar S Perke
Associate Dean and Principle, CoA, Dharashiv, VNMKV, Parbhani, Maharashtra, India

Ranjit V Chavan,
Associate Professor, Department of Agricultural Economics, CoA, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Ramkishan F Thombre
Assistant Professor, Department of Agricultural Economics, CoA, Golegaon, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
Pratik D Gaikwad
M.Sc. Scholar, Department of Agricultural Economics, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Price dynamics of chickpea in India: An econometric analysis

Pratik D Gaikwad, Sachin S More, Digambar S Perke, Ranjit V Chavan, and Ramkishan F Thombre

DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i9c.748

Abstract
The present study aimed to know whether the major markets of chickpea in India are seasonal and integrated and working efficiently. The seasonality was analyzed using the ratio-to-moving-average method, which revealed that arrivals peaked during February to April, while prices were highest from August to October, reflecting an inverse relationship between supply and price. Markets were selected viz., Damoh (Madhya Pradesh), Latur (Maharashtra), Rajkot (Gujarat), Lalitpur (Uttar Pradesh), and Gadag (Karnataka) on the basis of arrivals. The wholesale price and arrivals data were collected from AGMARKNET and APMCs for the period January 2015 to December 2024. The ADF and PP tests confirmed that price series were non-stationary at level but became stationary at first difference. The Johansen multiple co-integration test indicated a long-run equilibrium relationship among the selected markets with multiple cointegrating equations. Granger causality analysis showed both bidirectional and unidirectional linkages, highlighting price leadership of certain markets. The results confirmed that Damoh, Latur, Rajkot, Lalitpur, and Gadag markets are seasonal, integrated, and working efficiently.

Keywords: Chickpea, seasonality, ADF and PP test, co-integration, Johansen test, granger causality test

Introduction
Chickpea (*Cicer arietinum* L.), commonly known as gram or chana, is the most important pulse crop in India in terms of both area and production and plays a vital role in food and nutritional security. Globally, chickpea is cultivated on about 148.11 Lakh hectares with a production of 182.32 Lakh tonnes, where India is the largest producer and consumer, contributing nearly 70% of global output. Within India, Madhya Pradesh, Maharashtra, Rajasthan, Gujarat, and Uttar Pradesh dominate cultivation, together accounting for more than 95% of national production. Despite substantial domestic output, India continues to import pulses to meet rising demand, reflecting the need for improved productivity and market efficiency. Chickpea prices show seasonal variation, typically falling during the peak harvest season (February-April) and strengthening during lean months (August-October). Rich in protein (17-22%), carbohydrates (40-50%), and essential micronutrients, chickpea is a key component of vegetarian diets and supports rural livelihoods, especially for small and marginal farmers in semi-arid regions. Its ability to fix atmospheric nitrogen and adapt to dry climates enhances soil fertility and sustainability, making it strategically important in India's pulse economy. Therefore, the present study has undertaken with following specific objective:

1) To know the seasonality in chickpea prices in major markets of India.
2) To know the market integration among the major chickpea markets of India.

Methodology
Data Sources
This study utilizes authoritative secondary data sources to ensure analytical validity. Monthly time-series data on chickpea prices and arrivals were collected from Agricultural Produce Market Committees (APMCs) and the AGMARKNET portal for the period January 2015 to December 2024. Chickpea was chosen as the focal crop owing to its status as the most important pulse in India in terms of area, production, and consumption. The research is

confined to five major producing states viz., Madhya Pradesh, Maharashtra, Gujarat, Uttar Pradesh, and Karnataka and from each state, one representative market was selected based on the triennium average of arrivals such as Damoh, Latur, Rajkot, Lalitpur, and Gadag, respectively. To analyze the data, a suite of econometric tools was employed, including the ratio-to-moving-average technique, Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, Johansen's multiple co-integration test, and Granger causality test.

Analytical Tools

Seasonality Analysis

Monthly data on wholesale prices and market arrivals were utilized to analyze the seasonal patterns in the selected markets. To quantify the seasonal fluctuations in both prices and arrivals, seasonal indices were derived using the twelve-month ratio-to-moving-average technique.

- Step I involved calculating the 12-month moving totals, which were then divided by 12 to obtain the corresponding moving averages. These moving averages were further refined into a series of centred moving averages. A time span of 10 years of data was used for the computation of seasonal indices.
- Step II converted the original monthly values into percentages relative to their respective centred moving averages. This step also involved eliminating the irregular components from the time series. The resulting percentages were then grouped by month, and average values for each month were computed.
- Step III included adjusting the monthly average indices so that their total equalled 1200. This can be done by working out a correction factor and multiplying the average for each month by this correction factor.

The correction factor (K) is worked out as follows,
$K = 1200/ S$

Where, K is a correction factor S is the sum of average indices for 12 months Multiply K with the percentage of moving average for each month to obtain the seasonal indices.

Market co-integration

Testing of stationarity in price series

To address the issue of spurious regression that could result from non-stationarity, this study initially tested the stationarity of the time series data using the Augmented Dickey-Fuller (ADF) test. Before investigating any long-term equilibrium relationships among price series through co-integration techniques, it was necessary to confirm that the data were stationary. This step served as the foundation for all subsequent time series analyses. The ADF unit root test, developed by Dickey and Fuller (1979), was employed to identify whether a unit root existed in the data. The presence of a unit root at level form indicated non-stationarity. In such cases, the series was differenced once, and the ADF test was reapplied to assess whether the differenced series had achieved stationarity. The ADF test is estimated using the following regression equation:

$$\Delta P = \alpha_0 + \delta_{1\,t} + \beta_1 P_{t-1} + \sum_{j=0}^{q} \beta_1\, \Delta P_{t-j} + \varepsilon_t$$

$$\Delta P_t = P_t - P_{t-1},\ \Delta P_{t-1} = P_{t-1} - P_{t-2} \ldots\ldots\ldots\ldots\ \Delta P_{n-1} = P_{n-1} - P_{n-2}$$

Where,
P = Prices in each market
α_0 = Constant term or drift
q = The value of lags
ε_t = White noise error term

The values for this test statistic are compared with the dickey fuller values.

The null and alternate hypothesis tested in ADF are

- **(H0):** β1 (Coefficient of Pt-1) is zero.
- **(H1):** $\beta1 < 0$.

The null hypothesis in this context stated that the time series contained a unit root, indicating non-stationarity. In contrast, the alternative hypothesis asserted that no unit root was present, implying that the series was stationary.
Similar to the ADF test, PP test indicated the presence of a unit root at the level form, it suggested that the time series was non-stationary. In such cases, the series was transformed through first differencing, and the test was re-applied to the differenced series to determine stationarity.

Co-integration analysis using Johanson procedure

The Johansen cointegration test is a widely used statistical method for evaluating the existence and strength of long-term equilibrium relationships among non-stationary time series variables. This approach is applicable only when the time series are integrated of the same order, typically stationary at first difference. The Johansen framework includes two key techniques for determining cointegration: the Trace test and the Maximum Eigen value test. (Johansen, 1988; Johansen and Juselius, 1990) [5, 16]
The model with n variable vectors was given as,

$$x_t = A_1 x_{t-1} + \varepsilon_1$$

So that,

$$\Delta x_t = A_1 x_{t-1} - x_{t-1} + \varepsilon_1 = \prod x_{t-1} + \varepsilon_1$$

Where,
x_t, ε_t are (n×1) vectors,
A_I is (n×n) matrix of parameter,
I is (n×n) identity matrix
We test the rank of A_1-I matrix i.e., $\prod = A_1 - I$. If the rank is $\Pi=k$, then the series is stationary in nature. If the rank is $\Pi<k$, also known as reduced rank, then there exists cointegration among the series

Granger Causality Test

The presence and causality direction of long-run market price relationship can be assessed by using the Granger causality test directed within vector auto regressive (VAR) model. To perform the Granger causality analysis, an Autoregressive Distributed Lag (ADL) model was specified as follows:

$$X_0 = \sum_{i=1}^{n} \alpha_i\, Y_{0-i} + \sum_{i=1}^{n} \beta_i\, X_{0-j} + u_1$$

$$Y_0 = \sum_{i=1}^{n} \lambda_i\, Y_{0-i} + \sum_{i=1}^{n} \delta_i\, X_{0-j} + u_2$$

Where,
$\mu1$ & $\mu2$ are error terms

t = time period

X_0 & Y_0 are the price series of two different markets

To test the pattern of causality between two markets, 'F' test was used.

- **The null hypothesis H_0:** The lagged X_0 does not granger cause Y_0
- **The Alternative hypothesis H_1:** The lagged X_0 granger cause Y_0

Here 'F' statistic must be used in combination with the p value when deciding about the significance of the results.

If 'p' value is less than the alpha level, individual p values are studied to find out which of the individual variables are statistically significant.

Results and Discussion

Seasonal indices of market arrivals of chickpea in major markets of India.

Seasonal indices for arrivals have been estimated using the 12-month moving averages to determine the long-term seasonal variations of chickpea arrivals in the specified major markets. The results provide insights into cyclical patterns influenced by harvesting schedules and market behaviour. The seasonal indices of monthly market arrivals of chickpea in the major markets are presented in Table 1. In Damoh (Madhya Pradesh), the highest arrivals were observed in April (155.40), followed by March (135.40) and May (127.70). The lowest arrivals occurred in February (55.00), indicating limited supply just before the harvest. In Latur (Maharashtra), arrivals peaked in March (262.60), April (250.90), and May (208.40), reflecting the post-harvest surge. The leanest month was October (19.70), showing a sharp fall during the late *kharif/*early *rabi* lean season. In Rajkot (Gujarat), the highest indices were recorded in March (243.90) and April (237.90), while the lowest occurred in September (44.70), showing distinct post-harvest peaks and minimal arrivals during the rainy months. In Lalitpur (Uttar Pradesh), arrivals reached their maximum in May (184.70) and March (161.00). The lowest inflows were seen in December (45.40), pointing to a sharp decline after the marketing season. In Gadag (Karnataka), the arrivals were highest in February (347.10) and March (267.90), representing the strongest peaks among all markets. The lowest arrivals occurred in August (16.70), highlighting the sharpest seasonal contrast. These results reflect a strong seasonality across markets, with arrivals concentrated during the harvest and immediate post-harvest months (February to May) and minimal activity during the monsoon and late monsoon months

Table 1: Seasonality in Chickpea Arrivals in Major Markets of India

Month Market	Damoh (Madhya Pradesh)	Latur (Maharashtra)	Rajkot (Gujarat)	Lalitpur (Uttar Pradesh)	Gadag (Karnataka)
Jan	56.80	22.20	39.50	63.50	150.60
Feb	55.00	143.00	154.10	97.90	347.10
Mar	135.40	262.60	243.90	161.00	267.90
Apr	155.40	250.90	237.90	141.90	176.00
May	127.70	208.40	139.50	184.70	86.10
Jun	102.80	138.00	91.90	144.00	39.20
Jul	116.40	48.50	52.10	99.70	19.40
Aug	106.30	33.30	49.10	66.90	16.70
Sep	83.40	25.30	44.70	60.90	19.40
Oct	82.20	19.70	51.90	65.50	28.80
Nov	111.50	26.10	52.80	68.60	20.70
Dec	67.00	22.10	42.50	45.40	28.10

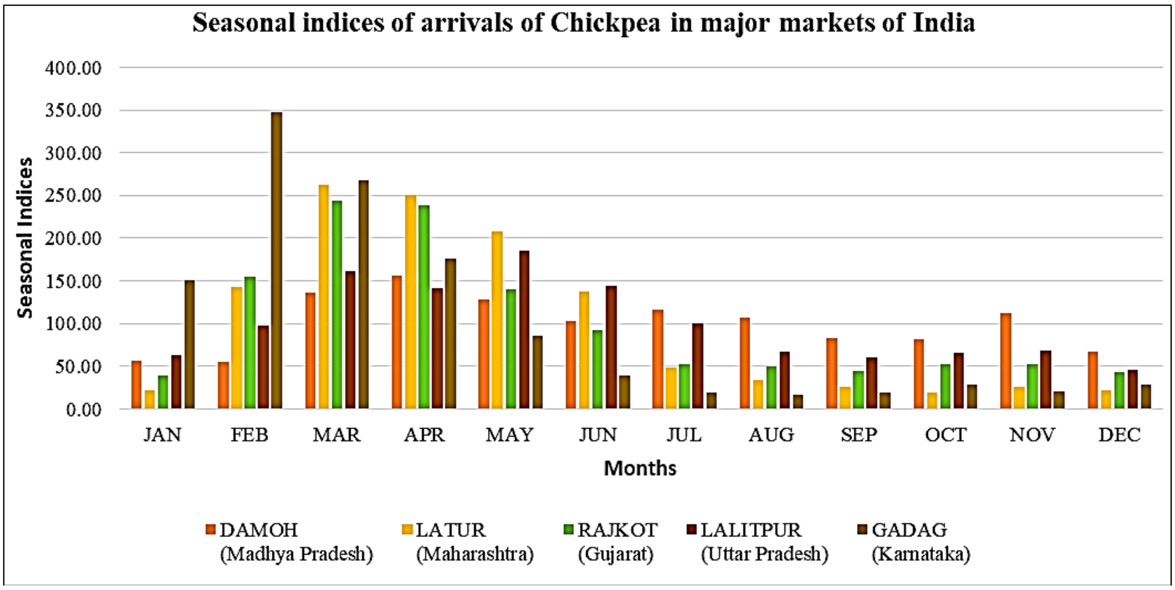

Fig 1: Seasonal indices of market arrivals of Chickpea in major markets of India.

(July-September). This aligns with chickpea's cropping cycle, where harvest occurs in rabi season and market inflows taper off during the rainy season, aligning Sonvanee and Koshta (2019) [14], found that peak Chickpea arrivals in Krishi Upaj Mandis of Chhattisgarh occurred during March-May, with the lowest during September-November and Balai *et al.* (2021) [1], They revealed that highest seasonal arrivals index of gram was observed in the month of June followed by May and July in KUMS, Bikaner.

The seasonal indices of all markets displayed in Figure 1. show that arrivals of chickpea peak from February to April in all the selected markets, while the lean season is typically observed during July to December. This pattern clearly reflects the influence of harvesting periods, climatic conditions, and supply chain dynamics associated with chickpea cultivation in India.

Seasonal indices of market prices of chickpea in major markets of India.

The seasonal indices of monthly market prices of chickpea in selected markets are presented in Table 2. The monthly market price results revealed that in the Damoh (Madhya Pradesh) market, the highest price index was observed in September (106.30), followed by October (105.40) and November (104.20), while the lowest price index was found in February (93.60). In the Latur (Maharashtra) market, the highest price index was recorded in October (107.20), followed by August (104.80) and November (103.60). The lowest price index occurred in March (94.00). In the Rajkot (Gujarat) market, the highest price index was in November (106.00), followed by October (105.50) and September (105.10). The lowest price index was observed in March (91.40). In the Lalitpur (Uttar Pradesh) market, the highest price index was recorded in September (105.50), followed by August (105.00) and June (104.10). The lowest price index was noted in March (92.50). In the Gadag (Karnataka) market, the highest price index was seen in September (105.10), followed by July (103.80) and August (102.40). The lowest price index was found in March (95.60). All markets showed that chickpea prices generally peak during the lean supply/off-season months (July-October) when arrivals decline, while the lowest prices are observed during the harvest months (February-March) due to abundant supply. This reflects the classical supply-demand dynamics of agricultural markets. Purushottam *et al.* (2013) [12] revealed that the seasonal pattern depicted that the prices of *rabi* pulses fall during March- June due to arrival of fresh stocks following crop harvest also Thakar *et al* (2017) [15], They studied Seasonal indices of market arrivals and prices of moth bean. The result revealed that seasonal price index was higher in the month of August and September in Palanpur market.

Table 2: Seasonality in Chickpea prices in major markets of India

Month Market	Damoh (Madhya Pradesh)	Latur (Maharashtra)	Rajkot (Gujarat)	Lalitpur (Uttar Pradesh)	Gadag (Karnataka)
Jan	97.30	97.10	95.70	96.70	95.90
Feb	93.60	96.60	92.10	93.60	96.10
Mar	95.90	94.00	91.40	92.50	95.60
Apr	98.70	97.50	99.10	97.10	99.50
May	97.20	96.50	100.10	100.60	98.50
Jun	97.60	99.20	99.50	104.10	98.50
Jul	99.40	101.60	103.50	101.50	103.80
Aug	103.70	104.80	103.00	105.00	102.40
Sep	106.30	105.20	105.10	105.50	105.10
Oct	105.40	107.20	105.50	104.80	103.60
Nov	104.20	103.60	106.00	99.90	103.20
Dec	100.80	96.50	99.00	98.80	98.00

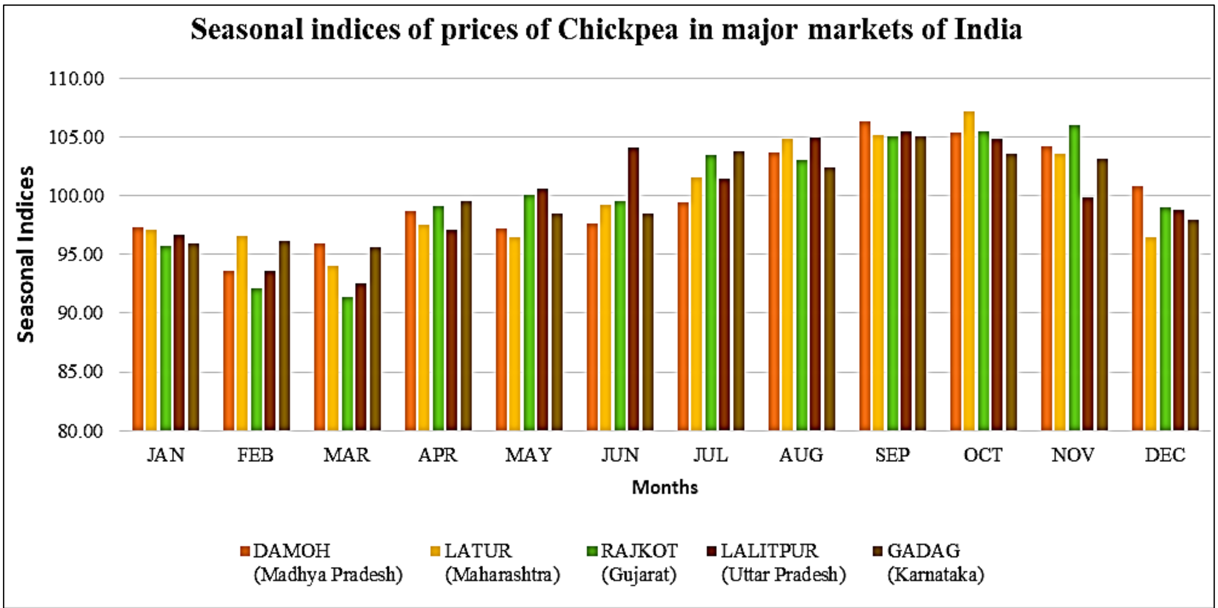

Fig 2: Seasonal indices of market prices of Chickpea in major markets of India.

The seasonal indices of all markets displayed in Figure 2 show that prices of chickpea were generally highest from August to October and relatively lower during the months of February to April. This trend indicates an inverse relationship between prices and arrivals, as the peak arrival season corresponds to lower prices, while lean arrival months witness higher price levels across the markets.

Augumented Dickey-Fuller (ADF) test

The Augmented Dickey-Fuller (ADF) test, a standard method for detecting unit roots, was employed to statistically verify the stationarity of chickpea prices in these major markets for Johansen co-integration analysis, and the results are summarized in Table 3.

Table 3: Estimates of Augmented Dickey-Fuller Test for stationarity and order of integration

Markets	At Level Data			First Differenced Data		
	None	Intercept	Trend and Intercept	None	Intercept	Trend and Intercept
APMC-Damoh						
‘t’ -Statistics	0.3020	-2.5117	-2.2437	-7.8231	-7.8003	-6.8434
Probability Value	0.7713	0.1156	0.4604	0.0000	0.0000	0.0000
Schwarz Criterion Value	-2.1740	-2.2254	-2.1355	-2.2526	-2.2099	-2.1307
APMC-Gadag						
‘t’ -Statistics	0.2720	-2.1313	-2.1421	-11.5102	-11.4691	-11.4210
Probability Value	0.7631	0.2330	0.5164	0.0000	0.0000	0.0000
Schwarz Criterion Value	-1.9676	-1.9665	-1.9243	-1.9700	-1.9283	-1.8851
APMC-Lalitpur						
‘t’ -Statistics	0.4771	-2.3320	-2.4495	-10.3953	-10.3889	-10.3376
Probability Value	0.8164	0.1640	0.3524	0.0000	0.0000	0.0000
Schwarz Criterion Value	-2.0566	-2.0638	-2.0259	-2.0639	-2.0243	-1.9804
APMC-Latur						
‘t’ -Statistics	0.2216	-2.1404	-2.1903	-10.1780	-10.1413	-10.0950
Probability Value	0.7487	0.2295	0.4897	0.0000	0.0000	0.0000
Schwarz Criterion Value	-1.8774	-1.8766	-1.8367	-1.8735	-1.8307	-1.7872
APMC-Rajkot						
‘t’ -Statistics	0.1569	-2.0029	-2.1320	-9.5653	-9.5292	-9.4818
Probability Value	0.7297	0.2853	0.5220	0.0000	0.0000	0.0000
Schwarz Criterion Value	-1.5848	-1.5788	-1.5414	-1.5955	-1.5525	-1.5086

The ADF test showed that the price series for all five markets-APMC-Damoh, APMC-Latur, APMC-Rajkot, APMC-Lalitpur, and APMC-Gadag were non-stationary at the level form across all model specifications (None, Intercept, and Trend and Intercept), as the test statistics did not exceed the corresponding critical values. High p-values further indicated the failure to reject the null hypothesis of a unit root. However, when tested in their first-differenced forms, the test statistics for all markets were highly significant under every specification, with p-values of 0.0000 in each case. The ADF values were more negative than the critical values at both the 5% and 1% significance levels, leading to the rejection of the null hypothesis. This confirms that the chickpea price series became stationary after first differencing in each market.

To ensure the robustness and conformity of the stationarity results, the Phillips-Perron (PP) test, an alternative unit root testing procedure, was also conducted alongside the Augmented Dickey-Fuller (ADF) test. The results reinforced the conclusion that while chickpea prices in the selected markets exhibit non-stationarity in their level forms, they become stationary after first differencing. Such conformity between the two testing procedures strengthens the reliability of the results and suggests that the chickpea price series follow an integrated order of I (1). The present study findings suggest that chickpea price series are non-stationary at levels but stationary after first differencing aligning with More *et al.* (2015) [7] study on sorghum in Maharashtra, Bharadwaj *et al.* (2015) [2] on future trading in soybean in India and Kumari *et al.* (2021) [6] in their analysis of wholesale Soybean prices in India, where ADF results showed non-stationarity at level and stationarity at first difference.

Vector Autoregressive Model

A crucial step in estimating the Vector Autoregressive (VAR) model is selecting an appropriate lag length, as the model’s accuracy and stability depend on it. Common criteria such as the Akaike Information Criterion (AIC), Final Prediction Error (FPE), Likelihood Ratio (LR) test, Bayesian Information Criterion (BIC), and Hannan-Quinn Criterion (HQC) help balance explanatory power with the risk of overfitting. Based on these criteria, particularly AIC, FPE, and LR, the optimal lag length was determined to be 2. Using this lag structure, the Johansen cointegration test (Table 4) confirmed the presence of cointegration among chickpea markets, indicating a long-run price association. A similar approach was adopted by Rani *et al.* (2017) [13].

Cointegration among the markets

Cointegration analysis revealed strong long-run price linkages among several chickpea market pairs, notably Damoh-Gadag, Damoh-Lalitpur, Damoh-Latur, and Damoh-Rajkot, where both Trace and Max-Eigen statistics significantly exceeded the 5% critical values with-values below 0.05 showed in table 4. Strong cointegration was also evident in Gadag-Lalitpur and Gadag-Latur, confirming stable price linkages. Moderate evidence of cointegration was found in pairs like Gadag-Rajkot and Lalitpur-Rajkot, while the strength of integration varied across markets depending on lag selection. Overall, these results confirm that chickpea markets of Damoh, Gadag, Lalitpur, Latur, and Rajkot are well-integrated, with prices moving together in the long run, ensuring efficient price transmission across regions. Similarly, Paul (2014) [9], Praveen and Inbasekar (2015) [11], and Paul *et al.* (2015) [2] also reported the existence of long-run equilibrium relationships and cointegration among various agricultural markets in India.

Table 4: Results of Johansen Cointegration test

Markets	Hypothesized No. of CS	Trace Statistics	Critical Value at 5%	Probability Value	Max Eigen Statistics	Critical Value at 5%	Probability Value	Lag Length (AIC)
Damoh -Gadag	None	31.71	15.49	0.0001	23.61	14.26	0.0013	6
	At most 1	8.10	3.84	0.0044	8.10	3.84	0.0044	
Damoh-Lalitpur	None	34.12	15.49	0.0000	26.94	14.26	0.0003	2
	At most 1	7.18	3.84	0.0073	7.18	3.84	0.0073	
Damoh-Latur	None	40.16	15.49	0.0000	34.48	14.26	0.0000	2
	At most 1	5.68	3.84	0.0171	5.68	3.84	0.0171	
Damoh-Rajkot	None	15.05	15.49	0.0581	9.07	14.26	0.2856	2
	At most 1	6.04	3.84	0.0139	6.04	3.84	0.0139	
Gadag-Lalitpur	None	22.15	15.49	0.0043	17.92	14.26	0.0126	2
	At most 1	4.23	3.84	0.0398	4.23	3.84	0.0398	
Gadag-Latur	None	32.15	15.49	0.0001	28.04	14.26	0.0002	1
	At most 1	4.11	3.84	0.0426	4.11	3.84	0.0426	
Gadag-Rajkot	None	14.26	15.49	0.0760	10.09	14.26	0.2057	1
	At most 1	4.17	3.84	0.0412	4.17	3.84	0.0412	
Lalitpur-Latur	None	30.95	15.49	0.0001	25.66	14.26	0.0005	1
	At most 1	5.29	3.84	0.0215	5.29	3.84	0.0215	
Lalitpur-Rajkot	None	20.52	15.49	0.0080	14.93	14.26	0.0391	2
	At most 1	5.59	3.84	0.0181	5.59	3.84	0.0181	
Latur-Rajkot	None	15.30	15.49	0.0534	10.41	14.26	0.1865	1
	At most 1	4.89	3.84	0.0269	4.89	3.84	0.0269	

Granger Causality test

The Granger causality test showed in table 5 revealed strong price interdependencies among chickpea markets in Damoh, Gadag, Lalitpur, Latur, and Rajkot.

Table 5: Pair -wise granger causality of chickpea prices in major market of India.

Markets	F-Statistics	Probability Value	Granger Cause	Direction
Damoh -Gadag	8.52	0.0004	Yes	Unidirectional
Gadag-Damoh	1.72	0.1845	No	
Damoh-Lalitpur	13.49	0.0001	Yes	Unidirectional
Lalitpur-Damoh	2.04	0.1347	No	
Damoh-Latur	2.83	0.0638	No	Unidirectional
Latur-Damoh	0.43	0.0143	Yes	
Damoh-Rajkot	3.34	0.0394	Yes	Unidirectional
Rajkot-Damoh	0.79	0.4568	No	
Gadag-Lalitpur	5.33	0.0063	Yes	Bidirectional
Lalitpur-Gadag	3.66	0.0293	Yes	
Gadag-Latur	2.05	0.1335	No	Unidirectional
Latur-Gadag	8.46	0.0004	Yes	
Gadag-Rajkot	0.08	0.9182	No	No causality
Rajkot-Gadag	2.93	0.0577	No	
Lalitpur-Latur	2.91	0.0592	No	Unidirectional
Latur-Lalitpur	8.25	0.0005	Yes	
Lalitpur-Rajkot	3.23	0.0438	Yes	Bidirectional
Rajkot-Lalitpur	6.03	0.0034	Yes	
Latur-Rajkot	1.95	0.1479	No	No causality
Rajkot-Latur	0.86	0.4243	No	

Bidirectional causality was observed in key pairs such as Gadag-Lalitpur and Lalitpur-Rajkot, indicating robust price integration. Several unidirectional linkages were also identified, including Damoh-Gadag, Damoh-Lalitpur, Damoh-Rajkot, Latur-Damoh, Latur-Gadag, and Latur-Lalitpur, highlighting the price leadership roles of Damoh and Latur. In contrast, no significant causality was found in other pairs, aligning with earlier studies Chavan *et al.* (2018) [3], Reported bidirectional causality in chickpea prices between Parbhani, Hingoli and Latur markets. Pandey *et al.* (2023) [8], reported that bidirectional causality among key wholesale markets like Narsinghpur, Daryapur, and Gulbarga in India.

Conclusion

The study revealed clear seasonal patterns in chickpea arrivals and prices, with arrivals peaking during February-May and prices reaching their highest levels from August to October, reflecting the inverse relationship between supply and price. Stationarity tests (ADF and PP) confirmed that price series are non-stationary at levels but become stationary after first differencing, indicating an integrated order of I (1). The Johansen cointegration test demonstrated strong long-run price linkages among key market pairs such as Damoh-Gadag, Damoh-Lalitpur, and Damoh-Latur, while moderate integration was observed in pairs like Gadag-Rajkot and Lalitpur-Rajkot. Granger causality analysis further identified bidirectional price transmission in pairs such as Gadag-Lalitpur and Lalitpur-Rajkot, along with unidirectional influences that highlight the price leadership roles of Damoh and Latur. These findings confirm that chickpea markets in India are well-integrated, with prices moving together over the long run, although the strength of integration varies across regions.

References

1. Balai HK, Singh H, Bairwa KC, Meena GL. To study of seasonal price behaviour of major rabi pulse crops in Rajasthan. J Prog Agric. 2021;12(2):54-9.
2. Bharadwaj SP, Paul RJ, Kumar A. Future trading in soybean: An econometric analysis. J Indian Soc Agric Stat. 2015;69(1):11-7.
3. Chavan SM, More SS, Choudhari PS. Price behaviour of chickpea in Maharashtra: An economic analysis. Int J Curr Microbiol Appl Sci. 2018;7(6):1359-65.
4. Dickey DA, Fuller WA. Distribution of the estimators for autoregressive time series with a unit root. J Am Stat Assoc. 1979;74(4):27-31.
5. Johansen S, Juselius K. Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxf Bull Econ Stat. 1990;52(2):169-210.
6. Kumari RV, Akula S, Gundu R, Panasa V. Co-integration of major soybean markets in India. J Oilseeds Res. 2021;38(1):84-91.
7. More SS, Kuthe SB, Saraswat V, Sanap DJ. Spatial price integration among major sorghum (rabi) wholesale markets of Maharashtra. Int J Agric Stat Sci. 2015;11(1):205-11.
8. Pandey G, Bansal S, Mohapatra S. Market integration of chickpea crop: evidence of India. J Agribus Dev Emerg Econ. 2023;15(1):1-18.
9. Paul RK. Forecasting wholesale price of pigeon pea using long memory time-series models. Agric Econ Res Rev. 2014;27(2):167-76.
10. Paul RK. Forecasting wholesale price of pigeon pea using long memory time-series models. Agric Econ Res Rev. 2014;27(2):167-76.
11. Praveen KV, Inbasekar K. Integration of agricultural commodity markets in India. Int J Soc Sci. 2015;4(1):51-6.
12. Purushottam, Verma P, Praharaj CS, Kanaujia VK. Wholesale price variability of raw and processed pulses - A case study. Legume Res Int J. 2013;36(5):429-35.
13. Rani R, Singh R, Tewari H, Singh SK, Singh PK. Integration of major Indian maize markets: A co-integration analysis. Int J Agric Stat Sci. 2017;13(2):601-6.
14. Sonvanee OP, Koshta AK. A study on arrivals and price behavior & forecasting of chickpea in Krishi Upaj Mandis of Chhattisgarh plains. Plant Arch. 2019;19(2):--.
15. Thakar KP, Singh SR, Soumya C, Chaudhari DD. An economic analysis of price movement of major pulse crops of North Gujarat. Int J Agric Sci. 2017;9(30):4422-6.
16. Johansen S. Statistical analysis of cointegration vectors. Journal of economic dynamics and control. 1988 Jun 1;12(2-3):231-54.