



A research study on market integration of cotton (*Gossypium* spp.) prices in various markets of Haryana

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ABSTRACT

The study examined the market integration of cotton (*Gossypium* spp.) prices across various markets in Haryana. Monthly time series data on cotton prices were collected from 2005–06 to 2021–22 from published sources such as the Agricultural Produce Market Committees (APMC) and the Cotton Corporation of India (CCI). To analyse market integration among the selected cotton markets, various techniques were employed, including the Granger Causality test, correlation analysis, the Johansen co-integration test, and the Augmented-Dickey Fuller (ADF) test. The correlation analysis revealed a high degree of correlation among the markets, with correlation coefficients ranging from 0.97–0.99. The ADF test indicated that the level values were less than the critical value, suggesting the presence of a unit root and non-stationarity. However, at the first difference, the ADF values were greater than the critical value, indicating that the prices were stationary and no unit root was present. The Johansen co-integration analysis showed that there were no co-integrating equations at the 5% significance level based on the Maximum Eigen Statistic, while at least four co-integrating equations were identified at the 5% significance level based on the Trace statistic. Lastly, the Granger Causality test was conducted to determine the direction of causation between the price series of the selected markets in Haryana, identifying the Dabwali market as the leading cotton market.

Keywords: Correlation analysis, Co-integration test, Granger causality test

The King of Fibers, cotton (*Gossypium* spp.), a member of the mallow family (Malvaceae) is a versatile crop growing in a range of agroclimatic conditions. Cotton holds a predominant place among many cash crops affecting the country's economic growth at several points by creating direct and indirect employment in the industrial and agricultural sectors. The crop is significant on a global scale and is mostly grown for its lint and seed. Numerous products in the textile industry use cotton. Additionally, it is utilized in the production of cotton paper, fishing nets, coffee filters and tents.

Cotton prices fluctuate based on the season and region. These price variations are significantly affected by international market trends and export policies. To improve cotton yields, it's important to provide growers with stable and fair prices and to implement effective technologies. In today's global market, prices play a vital role in guiding farmers on what types and quantities of goods to produce at specific times and locations. Prices also

help to analyse the distribution of income across sectors and the rate of capital investment in agriculture, as well as balance supply and demand (Chinnadurai *et al.* 2019). Therefore, examining pricing and market arrivals over time is essential for developing a robust agricultural policy. Analysing market integration is a key method for evaluating market performance. Market integration can be assessed by examining the strength and speed of price transmission between different markets within the state. The benefits for consumers and producers are influenced by how well different markets interact with each other. As production technology, input availability, and infrastructure have advanced through time, so have prices and arrival trends. By examining trends, we may determine the general direction of change in arrivals and pricing in various markets (Awal *et al.* 2007) and (Ghafoor *et al.* 2009). Therefore, the present study was carried out to examine the market integration of cotton prices across various markets in Haryana.

MATERIALS AND METHODS

Market integration: The monthly time series data on cotton prices from various published sources, Agriculture Produce Market Committees (APMC) and Cotton Corporation of India (CCI) for the selected major cotton markets: Adampur (ADM), Uklana (UKL), Dabwali (DAB),

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Sirsa (SIR), Jind (JIN), Uchana (UCH), Bhattukalan (BHA), Siwani (SIW), Fatehabad (FAT) and Bhiwani (BHA) from 2005–06 to 2021–22 have been used for the study of market integration. The analysis of market co-integration of cotton markets was undertaken as given below:

Correlation analysis: One simple technique to study market addition is to consider the correlation of price series for diverse markets. The correlation coefficient is known as the measure of the degree of linear association between the two available variables. Karl Pearson's correlation coefficient was employed to scrutinize the integration of cotton markets.

Correlation coefficient among two markets' prices X and Y:

$$r(X, Y) = \frac{\text{Cov}(XY)}{\sqrt{\text{Var}(X)}\sqrt{\text{Var}(Y)}}$$

For testing the connotation of the correlation coefficient (r), t-test was used:

$$\text{Null hypothesis } (H_0): p = 0$$

$$\text{Alternate hypothesis } (H_1): p \neq 0$$

Correlation significance was tested by using the following formula:

$$t = \frac{r}{1-r^2} \sqrt{n-2} \sim t(n-2) \text{ degrees of freedom}$$

Augmented Dickey-Fuller (ADF) test to check stationarity: Markets are considered to be integrated when long term equilibrium is there among them. Before analysing such connection stationarity of prices series is pre-requisite. The time series data on cotton prices in selected markets was analysed for stationarity using Augmented Dickey-Fuller (ADF) test. A stationarity series is the one whose parameters are independent of time, showing signs of continuous mean and also of variance and having autocorrelations that are invariant throughout the time. If the series is established to be non-stationary at level, the first disparity of the series is tested for stationarity. The number of times (d) a series is changed to make it stationary is referred to as the order of integration, I (d). The test was applied after running

regression of the following form:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^m \alpha_i \Delta Y_{t-i} + \varepsilon$$

where Y_t , Price of cotton in a specified market at time t; ΔY_t , $Y_t - Y_{t-1}$; ε , Pure white noise error term; m, Optimal lag which is chosen based on Schwartz information criterion.

Co-integration test: The co-integration method makes it clear how far the non-stationary series deviates from the extended run equilibrium relationship. Since co-integration connects the integrated route and steady state equilibrium, it provides the theoretical framework for analyzing the dynamics of sudden changes in two series as well as their important long-term data. For the long-term relationship linking the price series, the co-integration test by Johansen and Juselius (1990) was applied. To measure the quantity of the trace statistic, co-integrating vectors and the Maximum-Eigen statistic were proposed. The quantity of co-integrating vectors identified by these tests is a crucial indicator of the strength of price co-movement. The strength and consistency of pricing linkages grow as the number of co-integrating vectors rises.

Granger causality test: The test was engaged to know the direction of causation between the markets. When the co-integration relationship is currently between two variables, Granger Causality Test (Granger 1969) can be used to examine the course of the co-movement relationships. Granger causality test is endowed with testing whether variable X_t and Y_t variables causes each other. All permutations are possible: unidirectional Granger causality from X_t and Y_t or from Y_t to X_t , bidirectional causality or absence of causality. An autoregressive distributed lag (ADL) model for the Granger-causality test is specified as below:

$$X_t = \sum_{j=1}^n \alpha_j Y_{t-j} + \sum_{j=1}^n \beta_j X_{t-j} + \mu_{1t}$$

$$Y_t = \sum_{j=1}^n \alpha_j Y_{t-j} + \sum_{j=1}^n \beta_j X_{t-j} + \mu_{2t}$$

where t, Time period; μ_{1t} and μ_{2t} , Error terms; X and Y, Prices available from different markets.

Table 1 Coefficients of correlation of cotton prices in major cotton markets

Market	Adampur	Bhattukalan	Bhiwani	Dabwali	Fatehabad	Jind	Sirsa	Siwani	Uchana	Uklana
Adampur	1.000									
Bhattukalan	0.984**	1.000								
Bhiwani	0.916**	0.946**	1.000							
Dabwali	0.988**	0.982**	0.918**	1.000						
Fatehabad	0.983**	0.987**	0.951**	0.984**	1.000					
Jind	0.968**	0.975**	0.962**	0.971**	0.981**	1.000				
Sirsa	0.988**	0.991**	0.937**	0.987**	0.987**	0.975**	1.000			
Siwani	0.985**	0.989**	0.951**	0.984**	0.987**	0.982**	0.990**	1.000		
Uchana	0.951**	0.958**	0.936**	0.949**	0.968**	0.963**	0.951**	0.961**	1.000	
Uklana	0.983**	0.979**	0.941**	0.984**	0.984**	0.979**	0.980**	0.986**	0.958**	1.000

** Indicates significant at 1% level.

RESULTS AND DISCUSSION

The extent of association between the prices of one and other markets can be shown through a zero-order correlation matrix. Table 1 presents the results related to the correlation analysis of monthly wholesale prices of cotton among selected markets in order to check the integration. The correlation coefficient of prices was trending towards unity and significant at 1% level of significance indicating that the markets in Haryana are integrated with each other (Table 1). The markets of Haryana were highly correlated among each other with correlation value ranging from 0.97–0.99.

Augmented-Dickey Fuller test: Table 2 showed that in both cases, i.e. only intercept and intercept with trend, implying the existence of unit root and non-stationary, the ADF values in absolute terms for cotton price series of all the selected markets in Haryana were less than critical value (1%) given by Mackinnon Statistical Table at level. At the first difference, the ADF values for prices of cotton across all markets were from 10.17–13.46 (only intercept) and were found to be greater than the critical value (1%) of 3.45. In the case of an intercept with trend, the ADF values ranged from 10.35–13.56 and were also greater than the critical value (1%) of 4.04, indicating that all price series was stationary and free from unit root effects. Anuja *et al.* (2013), Wani *et al.* (2015) and Awasthi *et al.* (2016) also reported similar type of results.

Johansen co-integration analysis: The integration in

the cotton markets in Haryana was checked using the time series data collected from Agriculture Produce Market Committees (APMC) and Cotton Corporation of India (CCI) on the prices for the period 2005–06 to 2021–22 by employing Johansen multiple co-integration tests i.e. Maximum eigen statistic and Trace statistic is indicated in Table 3. Data indicated towards presence of no equations at 5% level of significance (Maximum Eigen Statistic) and at least four co-integrating equations were found at 5% level of significance (Trace statistic). Thus, there exists a long

Table 3 Results of Johansen co-integration analysis

Co-integrating equations	Max-eigen statistic	0.05 Critical value	Trace statistic	0.05 Critical value
None	58.51150	61.03407	258.8120*	219.4016
At most 1	48.19447	54.96577	200.3005*	179.5098
At most 2	39.09459	48.87720	152.1060*	143.6691
At most 3	31.02044	42.77219	113.0114*	111.7805
At most 4	26.65420	36.63019	81.99099	83.93712
At most 5	24.13166	30.43961	55.33679	60.06141
At most 6	15.37855	24.15921	31.20512	40.17493
At most 7	10.46187	17.79730	15.82658	24.27596
At most 8	3.589254	11.22480	5.364701	12.32090
At most 9	1.775447	4.129906	1.775447	4.129906

*Significance at 5% level.

Table 2 Results of Augmented-Dickey Fuller (ADF) test

Market	Particulars	At level	0.01 Critical Value	At first difference	0.01 Critical value
Adampur	Intercept	-1.10	-3.49	-10.74**	-3.49
	Intercept + Trend	-0.44	-4.04	-10.93**	-4.04
Ukalana	Intercept	-0.66	-3.49	-13.46**	-3.49
	Intercept + Trend	-2.22	-4.04	-13.56**	-4.04
Dabwali	Intercept	-1.24	-3.49	-10.17**	-3.49
	Intercept + Trend	-0.34	-4.04	-10.35**	-4.04
Sirsa	Intercept	-0.03	-3.49	-11.82**	-3.49
	Intercept + Trend	-1.73	-4.04	-11.89**	-4.04
Jind	Intercept	-0.16	-3.49	-11.66**	-3.49
	Intercept + Trend	-2.45	-4.04	-11.70**	-4.04
Uchana	Intercept	-1.33	-3.49	-12.84**	-3.49
	Intercept + Trend	-3.56	-4.04	-12.81**	-4.04
Bhattukalan	Intercept	-0.25	-3.49	-11.66**	-3.49
	Intercept + Trend	-1.43	-4.04	-11.74**	-4.04
Siwani	Intercept	-0.22	-3.49	-10.92**	-3.49
	Intercept + Trend	-1.67	-4.04	-10.99**	-4.04
Fatehabad	Intercept	-0.39	-3.49	-12.30**	-3.49
	Intercept + Trend	-2.39	-4.04	-12.34**	-4.04
Bhiwani	Intercept	-1.31	-3.49	-12.45**	-3.49
	Intercept + Trend	-3.69	-4.04	-12.39**	-4.04

**Significance at 1% level.

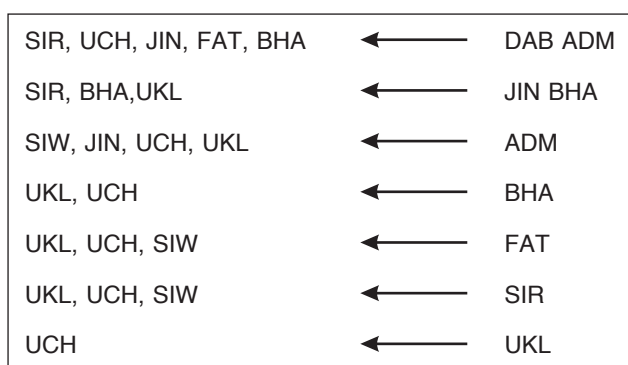


Fig. 1 Relationship between the cotton price series of Haryana markets.

Markets details are given under Materials and Methods.

run equilibrium relationship in between the cotton markets. Similar findings were also reported by Sundaramoorthy (2012), Khatkar *et al.* (2013), Paul and Sinha (2015) and Suresh (2017).

Granger causality test: Granger causality test is applied to know the direction of causation relationship between the price series of selected markets in Haryana and results are represented in Supplementary Table 1. Out of the cotton markets taken up for study in Haryana, the bidirectional causality relationship in price transmission was found between Dabwali and Adampur, Jind and Bhattukalan. The Dabwali market had influenced the cotton prices of Adampur, Uklana, Sirsa, Fatehabad, Uchana and Siwani markets in one way. While Fatehabad market had influenced the prices of Sirsa and Bhattukalan markets, prices of Adampur, Bhattukalan and Uchana markets and Siwani market had influenced the prices of Bhiwani market in unidirectional manner. The price relationship of different selected markets are also shown in Fig. 1. The above results are in conformity with the results of finding of Devi *et al.* (2016), Suresh (2017) and Saha *et al.* (2021).

Understanding the price relationships between markets is crucial for farmers. If farmers can determine which markets are interconnected in terms of pricing, they can make more strategic decisions. For example, if there is a price increase in one market, it might eventually lead to higher prices in their nearby market as well. The correlation analysis indicated that the prices series of selected cotton markets were highly correlated among each other. Johansen co-integration test showed no presence of equations at 5% level of significance (maximum eigen statistic) and at least four co-integrating equations were known at 5% level of significance (trace statistic). Thus, all the selected cotton markets in Haryana are found to be having a long run equilibrium relationship. The ADF values are in absolute terms, at first difference for cotton prices in all markets were more than the critical value at 1% level of significant. In the case of intercept with trend, the ADF values were also more than the 1% critical value of 4.04 indicating that all the price series were found to be stationary and also free

from consequences of unit root. The long run equilibrium relationship provides a clear evidence of the integration of the selected cotton markets. This specifies that prices in domestic major markets of Haryana are interdependent in response to changes in the demand and supply and other economic variables. Dabwali market was found as the main cotton market as it affected the prices of majority of the cotton markets i.e. Adampur, Uklana, Sirsa, Fatehabad, Uchana, Siwani and Bhattukalan market.

REFERENCES

- Anuja A R, Khar A, Jha G K and Kumar R. 2013. Price dynamics and market integration of natural rubber under major trade regimes of India and abroad. *The Indian Journal of Agricultural Science* **83**(5): 19–22.
- Awal MA, Sabur SA and Huq AA. 2007. Price integration in potato markets of Bangladesh. *Bangladesh Journal of Agricultural Economics* **30**(2): 69–80.
- Awasthi P K, Tomar A and Korde D. 2016. Market integration and price volatility across soybean markets in central India. *International Journal of Agricultural Sciences* **8**(51): 2349–52.
- Chinnadurai M, Sangeetha R, Anbarassan A and Kavitha B. 2019. Price integration analysis of major cotton domestic markets in India. *International Journal of Agricultural Sciences* **15**(1): 141–47.
- Devi P R, Devi B I, Aparna B, Naidu M G and Prasad S V. 2016. A study on horizontal integration of selected groundnut markets of India. *International Journal of Agricultural Sciences* **8**(34): 1715–18.
- Ghafoor A, Mustafa K, Mushtaq K and Abdulla 2009. Co-integration and causality: An application to major mango markets in Pakistan. *Lahore Journal of Economics* **14**: 85–113.
- Granger C W J. 1969. Investigating causal relations by econometric models for cross-spectral methods. *Econometrica* **37**(3): 424–38.
- Johansen S and Juselius K. 1990. Maximum likelihood estimation and inference on co-integration with applications to the demand for money. *Oxford Bulletin Economics and Statistics* **52**(2): 127–37.
- Khatkar R K, Singh V K, Karwasra J C and Bhatia J K. 2013. Market integration and price volatility in domestic mustard markets. *Indian Journal of Economics and Development* **9**(2): 114–23.
- Paul R K and Sinha K. 2015. Spatial market integration among major coffee markets in India. *Journal of the Indian Society of Agricultural Statistics* **69**(3): 281–87.
- Saha N, Kar A, Jha K G, Kumar P, Venkatesh P and Kumar R. 2021. Integration of prices in major markets of onion and potato in India. *The Indian Journal of Agricultural Sciences* **91**(9): 1290–95.
- Sundaramoorthy C. 2012. 'Analysis of price dynamics and market integration in cotton value chain under different Trade Regime'. PhD Thesis, ICAR-Indian Agricultural Research Institute, New Delhi.
- Suresh S, Singh J and Kumar S. 2017. Co-integration of cotton prices in Indian markets. *Journal of Agricultural Development and Policy* **27**(1): 9–16.
- Wani M H, Paul R K, Bazaz N H and Manzoor M. 2015. Market integration and price forecasting of apple in India. *Indian Journal of Agricultural Economics* **70**(2): 169–81.