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# Variability and Market Integration of Fenugreek Prices in Rajasthan

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**ABSTRACT**

Rajasthan state is prime producer of fenugreek in India. The present study is confined to secondary time series data on price and arrivals of fenugreek in Rajasthan. The selected study period was varied from January, 2011 to December, 2020. The investigation was undertaken with specific objectives of variability in prices of fenugreek in selected markets of Rajasthan and market co-integration among prices of fenugreek in the study area. The statistical tools *viz.,* Cuddy-Della Valle instability index, Augmented Dickey Fuller and Johansen's multiple Co-integration test were applied. It could be concluded from the findings that prices of fenugreek were more instable in short-run (58.41%) in 2014, when compared with the long-run run period instability index (30.54%) in Kota market. The seasonal price and arrivals indices indicated that maximum arrivals and prices indices of fenugreek were reported during peak season and crop season respectively. The price of fenugreek in the selected markets viz., Kota, Bikaner and Nokha were not moved together in long-run. It means markets are not integrated in directions and causality of fenugreek prices in the selected markets.

**Keywords:** Co-integration, Cuddy-Della Vale instability, Mandi association, Sale price instability, Stationarity

Spices production are being an important component of horticulture and play pivotal role in Indian agriculture. The International Standard Organization is specified about 109 spices in the world, out of these 75 species are grown in the India. Only sixteen spices *viz.,* black pepper (*Piper nigrum*), cardamom (*Elettaria cardamomum*), ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), clove (*Syzygium aromaticum*), chilli (*Capsicum annuum*), garlic (*Allium sativum*), saffron (*Crocus staivus*), celery (*Apium gravrolens*), cumin (*Cuminum cyminum*), coriander (*Coriandrum sativum*), fennel (*Foeniculum vulgare*), fenugreek (*Trigonella foenum-graecum* Linn), ajwain

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(*Trachyspermum ammi*), dill (*Anethum sowa*), and nigella (*Nigella sativa*) are essential in India (RSAMB, 2010). Since immemorial time, India's land is known as house of spices on the earth. Seed spices in the country contribute about 36 and 19 per cent share in area and production of total spices (Spice Board of India, 2020). Most of the seed spice crops are cultivated in the arid and semi arid climatic zones of India during winter season (Kumawat, 2014). Fenugreek (*Trigonella foenum-graecum* Linn) seed spice crop is one of them, grown for leaves and seeds throughout the country. It had prime importance in Indian kitchen and medicinal purposes. Fenugreek is used as herb (dried/fresh leaves), vegetable (fresh leaves sprouts and micro-greens) and spices (seeds) in Indian kitchen. World Health Organization has depicted that about 80 per cent people are preferred to use man-made medications of plants for different diseases *viz.*, bacterial, fungal and viral contagion (Kumar and Reddy, 2012). Fenugreek seeds extract are good source of anticancer and antibacterial agents (Al-Timimi, 2019; Alwan *et al.*, 2017). The petroleum ether extract of fenugreek seeds are used in anti-inflammatory and anti-arthritic activities due to the presence of linolenic and linoleic acids (Pundarikakshudu *et al.* 2016).

Throughout the country, fenugreek production during 2019-20 was 182170 tonnes in which 36.63 per cent share is contributed by the Rajasthan state solely. Rajasthan state is second largest producer of fenugreek in the country followed by Gujarat, Haryana and West Bengal. Fenugreek play a significant role in our annual spice export basket. We could not ignore that there are significant competitors in the international market wings. The existence of sound market structure is essential condition for providing incentive prices and boost-up the fenugreek production in the country. The production of fenugreek could logically be augmented by either expanding area or yield of the crop or both. However, crop production is also affected by fluctuation in market prices. Therefore, it is necessary to recognize the price behaviour of fenugreek over time and space in the Rajasthan. Such studies are beneficial to fenugreek growers in determining the optimum time to dispose of their produce and maximize profits. With the above mentioned facts in mind a study was conducted with the following objectives such as to examine the relationship between arrivals and prices of fenugreek in Rajasthan; to analyze the price instability of fenugreek in selected markets of Rajasthan and market integration of fenugreek in selected markets of Rajasthan.

## MATERIALS AND METHODS

A systematic investigation procedure is essential to suggest the recommendations on findings of the pre-decided objectives. The present study is confided to secondary information on market arrivals and prices of fenugreek in selected markets of Rajasthan. During triennium ending average 2018-19 to 2020-21, Rajasthan state is holding maximum area (50989 ha) under fenugreek cultivation in the country (Anonymous, 200-21). Based on the maximum arrivals of fenugreek in the market, three Krishi Upaj Mandi Samities (KUMS) *viz.*, Bikaner, Nokha and Kota markets were selected. The study period from January, 2011 to December, 2020 was decided based on the availability of data on arrivals and price. The time series data on monthly arrivals and modal price were collected from respective Krishi Upaj Mandi Samiti (KUMS) of selected markets, Agmarknet web portal and Directorate of Agricultural Marketing, Government of Rajasthan. The missing data of arrivals quantity and modal prices in any month were computed with the help of interpolation method. The following analytical tools were used to compute the seasonal index, price instability and market integration.

**Seasonal Index**: The ratio to moving average method was used to compute the seasonal indices of price and arrivals of fenugreek.

$$Y = TSCI$$

$$\frac{Y}{\text{Moving Average}} = \frac{TSCI}{TC} = SI$$

If the sum of seasonal indices is greater or less than 12 hundred then it was adjusted by using the following formula:

$$K = \frac{1200}{S}$$

Where; K = Correction factor

S = Summation of seasonal indices

**Instability**: The short-term and long-term instability in price of fenugreek was measured by Coefficient of Variation (CV) and Cuddy-Della Valle instability index, respectively.

**Short run instability in prices**

$$CV = \frac{\sqrt{\frac{\sum d^2}{(n-1)}}}{\bar{X}} \times 100$$

Where; CV = coefficient of variation,

$d^2$ = Squares of deviations from arithmetic mean. *i.e.* $d^2 = (X_i - \bar{X})^2$

$(X_i - \bar{X})^2$ =Deviation of monthly modal price form $\bar{X}$

$\bar{X}$ = Arithmetic mean of monthly modal price

$n$ = Number of observations in months

**Long-term instability in prices**: Cuddy-Della Valle instability index was developed by John Cuddy and Della Valle in 1978 for measuring the instability over the period. It is commonly used as measure of instability in chronological data (Singh and Byerlee, 1990; Deb *et al.* 1999 and Bairwa *et al.* 2021). The algebraic form of this index is given as follow:

$$I = CV \times \sqrt{(1 - Adj\ R^2)}$$

Where, I is the instability index (%), $CV = \frac{SD}{AM} \times 100$

CV is the coefficient of variation (%),

SD is standard deviation

AM is Arithmetic mean

$Adj\ R^2$ is the adjusted R square = coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

**Market integration**: Before testing co-integration, the time series data on monthly price has to be checked for its stationarity. The Dickey Fuller (DF) and Augmented Dickey- Fuller (ADF) tests were mostly used for testing unit roots or non-stationarity in time series data. However, Augmented Dickey Fuller test removes all autocorrelation in the secular time series data and then computed non-stationarity using same procedure as DF test. This test was conducted on the variables at level (actual price data) and first differences (Dickey and Fuller, 1979). There are various techniques to study the market integration *viz.,* (i) Johnson multiple co-integration test to find out the long run equilibrium among markets (Johansen, 1988); (ii) Vector Error Correction Model (VECM) to capture the speed of adjustment to deviations in long run equilibrium and (iii) Pair wise Granger Casualty test to analyze the influence of prices of each market on all other markets (Engle and Granger, 1987). In the present study all techniques were used to worked out the order of integration, short run & long run association, speed of adjustment to equilibrium and influence of prices of one market on others of the same commodity.

Seasonal indices and co-integration analysis among markets prices were computed by using Minitab-17 and E-VIEWS-7 version 7.0.0.1 software, respectively.

## RESULTS AND DISCUSSION

**Seasonal deviation in price and arrivals:** The arrivals and price indices of fenugreek in KUMS, Kota, Bikaner and Nokha were represented in the Table 1. It could be seen from the table that during entire study period, the wide range of seasonal arrivals indices of fenugreek was varied from 36.05 per cent in February to 250.74 per cent in the month of April in Kota market. The lower seasonal indices of arrivals were highly prominent from August to March in the Kota market except December. The arrivals were started increasing after the month of February and increased upto June month. During April to June months, the seasonal indices of arrivals was much higher than 100 per cent, which indicated peak arrivals of fenugreek in the selected market whereas remaining periods showed lean arrivals. At the same time, the fenugreek prices show an increasing trend from February to April and September to November afterward declining trend. During April month, this market had provided highest fenugreek price to hit the largest quantity of fenugreek in peak season. During peak season, there was a positive relationship between price and arrivals; it might be exist in the market when early sowing growers of fenugreek arrived in first week of April month and late sowing farmers move toward the market upto last day of April. The lowest arrivals of fenugreek seeds in pre-harvest season (December-February) also provide better price to farmers. These findings were similar

**Table 1:** Seasonal indices of monthly arrivals and price of fenugreek in selected Krishi Upaj Mandi Samities of Rajasthan (2011-2020)

| Month | Kota grain *mandi* | | Bikaner grain *mandi* | | Nokha grain *mandi* | |
|---|---|---|---|---|---|---|
| | Arrivals | Price | Arrivals | Price | Arrivals | Price |
| January | 67.77 | 100.56 | 15.15 | 102.19 | 46.33 | 101.48 |
| February | 36.05 | 90.70 | 23.93 | 95.62 | 36.13 | 98.76 |
| March | 76.71 | 100.35 | 44.21 | 97.65 | 41.08 | 92.71 |
| April | 250.74 | 104.67 | 438.77 | 100.88 | 458.4 | 100.14 |
| May | 211.24 | 100.98 | 492.61 | 107.37 | 317.00 | 98.24 |
| June | 131.01 | 101.38 | 97.41 | 89.77 | 111.89 | 98.51 |
| July | 73.38 | 100.31 | 32.19 | 105.00 | 59.96 | 101.27 |
| August | 53.40 | 103.55 | 12.86 | 93.63 | 20.31 | 102.29 |
| September | 45.44 | 96.21 | 14.90 | 99.35 | 17.2 | 99.95 |
| October | 76.88 | 96.20 | 16.53 | 104.05 | 30.16 | 98.72 |
| November | 72.45 | 103.64 | 8.17 | 105.51 | 24.38 | 105.44 |
| December | 104.94 | 101.45 | 3.27 | 98.98 | 37.16 | 102.50 |

**Source:** Author's own computation.

with the results of (Areef, 2018), who had reported maximum seasonal price indices of onion in July-August months at Bangalore and Kurnool markets where attractive prices coerced to farmers for selling larger onion quantity in the markets.

The results of seasonal indices for arrivals in Bikaner market reported that maximum arrivals of fenugreek in the selected markets were observed during peak arrivals season (April to June) and in rest of the period arrivals was very low. The highest and next to highest arrivals seasonal indices of fenugreek were reported in the month of May (492.61%) and April (438.77%) in the market. This is the indication of fresh arrivals of fenugreek in the market. In the mean time, seasonal price indices of fenugreek showed increasing trend during February to May and August to November periods. The highest price index of fenugreek crop was found in the month of May (107.37%) and lowest was recorded in the month of June (89.77%). Yakubbhai (2017) in his study also reported similar trend behaviour of arrivals and price indices of fenugreek in the Gujarat state during 2002-2012.

In case of KUMS, Nokha, the wide range of seasonal arrivals indices of fenugreek was varied from 17.20 per cent in September to 458.40 per cent in the month of April. The lower seasonal indices of arrivals were highly prominent from July to March in the Nikha market. The arrivals were started increasing after the month of March and increased upto June month. During April to June months, the seasonal indices of arrivals was recorded higher than 100 per cent, which indicated peak arrivals of fenugreek in the selected market whereas remaining periods showed lean arrivals. During same time, the seasonal price indices of fenugreek showed an increasing trend from June to August and October to November afterward declining trend. During November month, this market had provided highest fenugreek price to hit the largest quantity of fenugreek in peak season. During peak season, there was a negative relationship between price and arrivals; it might be exist in the market accordance to thumb rule of demand-supply. The lowest arrivals of fenugreek seeds in crop season (September-November) also provide better price to farmers. Meera and Sharma (2016) were reported similar findings for wheat in major APMCs of Sri-Ganganagar districts during pertained study period from 2005 to 2014.

**Short-run price instability:** The short-run instability in monthly price of fenugreek in KUMS, Kota, Bikaner and Nokha were represented in Tables from 2 to 4. The study period from January, 2011 to December, 2020 was also selected to assess the inter-seasonal price instability of fenugreek in selected markets of Rajasthan. According to marketing season

year was divided into four seasons viz., crop season, pre-harvest season, peak season and post harvest season.

**Table 2:** Season wise coefficient of variation of fenugreek price in KUMS, Kota (CV in Per cent)

| Year | Crop season (Sept.-Nov.) | Pre-harvest season (Dec.-Feb.) | Peak season (March-May) | Post peak season (June-August) |
|---|---|---|---|---|
| 2011 | 7.26 | 7.30 | 4.64 | 3.00 |
| 2012 | 6.38 | 9.80 | 5.88 | 12.58 |
| 2013 | 7.28 | 5.51 | 3.73 | 1.04 |
| 2014 | 12.94 | 58.41 | 19.10 | 16.58 |
| 2015 | 8.03 | 12.49 | 20.96 | 9.12 |
| 2016 | 0.97 | 12.49 | 8.10 | 5.59 |
| 2017 | 9.48 | 5.04 | 11.12 | 7.27 |
| 2018 | 10.86 | 11.87 | 1.69 | 1.72 |
| 2019 | 7.15 | 9.23 | 8.50 | 5.16 |
| 2020 | 3.57 | 25.87 | 0.93 | 10.26 |

**Source:** Author's own computation.

Table 2 presented results of inter-seasonal price instability of fenugreek in Krishi Upaj Mandi Samiti, Kota. It was observed from the table that during 2011-2020, the extent of price instability varied from 0.93 per cent in peak season in year 2020 to 58.41 per cent in pre-harvest season of year 2014 in Kota market. The wide varying range of fenugreek price instability was recorded in pre-harvest season (5.04 to 58.41%) followed by peak season (0.93 to 20.96%), post-peak season (1.04 to 16.58%) and crop season (0.97 to 12.94%) in Krishi Upaj Mandi Samiti, Kota. The intra-year price variation was observed more during pre-harvest season followed by peak season, post-peak season and crop season. The variation in price of fenugreek was comparatively more pronounced in the year 2014, 2015 and 2020. Prahladbhai (2005) reported in his study that intra-year instability in monthly price of groundnut, mustard and castor were higher as compared to sesame during 1988-2003.

The results of inter-seasonal price instability of fenugreek in Krishi Upaj Mandi Samiti, Bikaner was presented in Table 3. It was revealed from the table that during entire study period, season wise highest price fluctuation of fenugreek was recorded at 18.20, 34.70, 18.02 and 19.53 per cent in crop season (2016), pre-harvest season (2020), peak season (2019) and post peak season (2012), respectively in the Krishi Upaj Mandi Samiti, Bikaner. Among all four seasons of the study period, price fluctuation of fenugreek was observed highest (34.70%) in pre-harvest season and lowest (1.26%) in peak arrival season in Krishi Upaj Mandi Samiti, Bikaner. The inter-seasonal price of fenugreek was more volatile during post-peak season followed by pre-harvest season, peak season and crop season equally. Bairwa *et al.* (2021) reported similar findings in his study of intra-year instability in price of rapeseed-mustard during 2011-2020.

**Table 3:** Season wise coefficient of variation of fenugreek price in KUMS, Bikaner (CV in Per cent)

| Year | Crop season (Sept.-Nov.) | Pre-harvest Season (Dec.-Feb.) | Peak season (March-May) | Post peak season (June-August) |
|---|---|---|---|---|
| 2011 | 2.59 | 1.92 | 14.42 | 5.86 |
| 2012 | 1.90 | 5.59 | 8.83 | 19.53 |
| 2013 | 6.80 | 5.60 | 3.52 | 15.64 |
| 2014 | 2.78 | 13.61 | 9.08 | 16.30 |
| 2015 | 4.13 | 1.39 | 1.26 | 4.71 |
| 2016 | 18.20 | 12.04 | 3.12 | 15.87 |
| 2017 | 9.41 | 17.96 | 12.98 | 3.06 |
| 2018 | 17.10 | 10.41 | 5.78 | 9.67 |
| 2019 | 16.87 | 12.23 | 18.02 | 9.53 |
| 2020 | 1.64 | 34.70 | 3.64 | 15.70 |

**Source:** Author's own computation.

In case of Krishi Upaj Mandi Samiti, Nokha, the coefficient of variation of fenugreek price in crop season, pre-harvest season, peak season and post peak season were presented in Table 4. It could be analyzed from the table that extent of price instability was observed at 49.14 per cent in pre-harvest season and 0.27 per cent in peak season in the market during 2014.

Among all seasons, upmost price instability of fenugreek was recorded at 17.58, 49.14, 19.21 and 18.72 per cent in crop season (2014), pre-harvest season (2014), peak season (2019) and post-peak season (2020), respectively. During entire study period, wide range of price fluctuation was seen in pre-harvest season (6.78 to 49.14%) followed by peak

season (0.27 to 19.21% ), post-peak season (0.51 to 18.72%) and crop season (1.14 to 17.58%) in Nokha market. The coefficient of variation in fenugreek prices during individual year was observed to be highest in pre-harvest season followed by peak season and post-peak season while it was reported lowest in crop season. The highest price instability in pre-harvest season might be due to irregular arrivals of fenugreek in the market; it affected to fenugreek price reciprocally in the market.

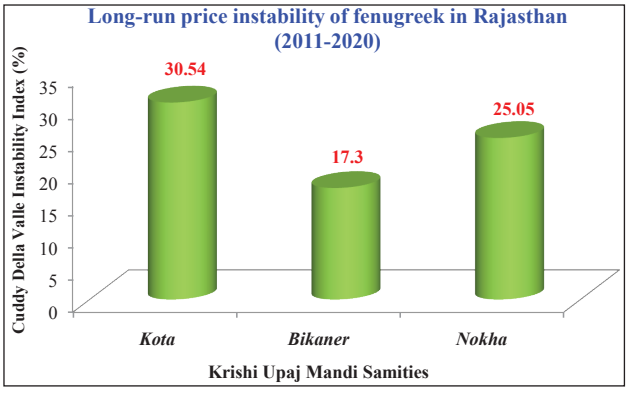
**Table 4:** Season wise coefficient of variation of fenugreek price in KUMS, Nokha (CV in Per cent)

| Year | Crop season (Sept.-Nov.) | Pre-harvest season (Dec.-Feb.) | Peak season (March-May) | Post peak season (June-August) |
|---|---|---|---|---|
| 2011 | 2.56 | 7.57 | 2.35 | 2.38 |
| 2012 | 1.14 | 7.27 | 10.78 | 2.72 |
| 2013 | 9.23 | 14.74 | 0.48 | 3.02 |
| 2014 | 17.58 | 49.14 | 0.27 | 17.10 |
| 2015 | 14.99 | 30.31 | 12.62 | 13.92 |
| 2016 | 2.00 | 11.76 | 11.90 | 2.87 |
| 2017 | 5.89 | 6.78 | 6.41 | 4.76 |
| 2018 | 6.75 | 9.10 | 0.44 | 3.49 |
| 2019 | 5.73 | 13.15 | 19.21 | 0.51 |
| 2020 | 2.90 | 18.51 | 1.92 | 18.72 |

Source: Author's own computation.

**Long-run price instability:** The degree of long-run instability in monthly prices of fenugreek in selected markets of Rajasthan were calculated and presented in Fig. 1. It was revealed from the figure that market price of fenugreek was instable in all three markets *viz.*, KUMS, Kota, KUMS, Bikaner and KUMS, Nokha. The highest variation in monthly price of fenugreek was recorded in Krishi Upaj Mandi Samiti, Kota (30.54%) followed by KUMS, Nokha (25.05%) and KUMS, Bikaner (17.30%). Similarly, Kolageri and Banakar (2018) examined in their study that turmeric price was recorded highest degree of instability (61.78%) in Chamaraj Nagar market of Karnataka for the study period from 2003-04 to 2017-18.

**Market integration analysis:** When markets are integrated, the market-operating system in integrated markets is uniform, as in a single market system. The co-integration technique is used to test common trends in multivariate secular data series, as well as dynamic long-run and short-run modeling. The Augmented Dickey Fuller test is used to determine whether there is a unit root in level data or not. To investigate the co-integration between prices of fenugreek in selected markets, the Johansen's multiple co-integration, Vector Error Correction, and Granger Causality tests were computed using E-views-7 software for the time series data.




**Source:** Author's computed from secondary published time series data

**Fig. 1:** Long run instability in monthly price of Fenugreek in markets of Rajasthan

**Stationarity analysis:** The results of unit root test for fenugreek prices in Kota, Bikaner, and Nokha KUMS were shown in Table 5. As per the Augmented Dickey Fuller test, the null hypothesis of an integration of order I (1) could not be rejected for fenugreek prices in all selected markets where the non-stationary hypothesis was rejected (P>0.05). That is, fenugreek prices are integrated in the same order or are non-stationary at the level in all three KUMS, Kota, Bikaner, and Nokha. At first difference, the price series of fenugreek were found to be stationary in all selected KUMS, namely Kota, Bikaner, and Nokha. After testing the non-stationary time series of fenugreek price, it is also required that the coefficient of variable be negative for the Augmented Dickey Fuller models to be viable at level data. Furthermore, the coefficient of variable was found to be negative in all three forms of model. As a result, the integration order was observed to be one. In their study, Ali and Gupta (2011) found that spot and future market prices of pepper were unit root at the level and non-stationary at the first difference in India.

**Table 5:** Results of Augmented Dickey Fuller test for presence of unit root in fenugreek prices

| Markets | Model | Level data | | | First difference data | | |
|---|---|---|---|---|---|---|---|
| | | *t-Statistic* | *P-value* | Coefficient value (Y-1) | *t-Statistic* | *P-value* | Coefficient value (Y-1) |
| Kota | Intercept | -2.322455 | 0.1667 | -0.076749 | -8.409736 | 0.0000 | -0.983479 |
| | Trend & intercept | -2.601540 | 0.2805 | -0.092771 | -8.377079 | 0.0000 | -0.985593 |
| | None | 0.070266 | 0.7032 | 0.000757 | -8.405093 | 0.0000 | -0.976840 |
| Bikaner | Intercept | -1.954179 | 0.3067 | -0.167136 | -17.77147 | 0.0000 | -1.462812 |
| | Trend & intercept | -2.690623 | 0.2425 | -0.243738 | -17.87757 | 0.0000 | -1.470545 |
| | None | 0.274369 | 0.7639 | 0.003514 | -17.81424 | 0.0000 | -1.461341 |
| Nokha | Intercept | -2.182051 | 0.2139 | -0.087526 | -13.45647 | 0.0000 | -1.221245 |
| | Trend & intercept | -2.838482 | 0.1867 | -0.135346 | -13.40967 | 0.0000 | -1.222463 |
| | None | 0.298049 | 0.7704 | 0.003706 | -13.44994 | 0.0000 | -1.216382 |

**Source:** Author's own computation from time series data of prices.

**Johansen's multiple co-integration analysis:** The presence of co-integration between fenugreek prices in KUMS was determined using Johansen's multiple co-integration test. Table 6 presents the results of long run co-integration analysis for selected KUMS, namely Kota, Bikaner, and Nokha. The table showed that during the entire study period, the values of Trace statistic and maximum Eigen of the Johansen's multiple co-integration test revealed no co-integration equations at the 5 per cent level of significance. It implies that selected markets did not have a long run association for fenugreek prices in Rajasthan, i.e. fenugreek prices in selected markets did not move together over time.

**Table 6:** Results of Johansen multiple co-integration analysis of fenugreek price

| Hypothesized no. of CE(s) | Eigen value | Trace statistic | 0.05 Critical value | *P-value* |
|---|---|---|---|---|
| None | 0.112874 | 22.24301 | 29.79707 | 0.2852 |
| At most 1 | 0.067686 | 8.230077 | 15.49471 | 0.4411 |
| At most 2 | 0.000257 | 0.030027 | 3.841466 | 0.8624 |

**Source:** Author's own computation.

Therefore, the Vector Error Correction Model (VECM) and the Granger-causality tests were not applied for assessing directions and causality relationship between prices of fenugreek in selected markets. It could be concluded from the findings that selected markets are poor in the strength and stability of fenugreek price linkage in the studied markets. In contrary Sahu *et al.* (2019) found in their study a long-run relationship between daily spot and future prices of chilli, turmeric, and cumin in India during October, 2015 to April, 2017. Based on findings it was recommended that price variability in short run could be minimized through developing storage infrastructure and easy finance facility for farming community.

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