A Causal Nexus Of Indian Agricultural Futures Market In Pre- And Post-COVID19 Outburst: A Case Of India’s First Tradable Agri-Futures Index

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ABSTRACT
The research article examined the causal nexus in between two listed (NCDEX) benchmark agricultural futures indices in India, say, NKRISHI (Weighted Index) and AGRIDEX (Return based Index). Daily closing futures prices has been retrieved from official platform of NCDEX dated from April 1, 2018 to January 29, 2020 as first period (Pre-COVID19) and from January 30, 2020 to October 11, 2021 as second period (During COVID19). The causal nexus has been examined by using of Unit Root test (ADF), pairwise Granger Causality and Johansen Co-integration tests. The empirical investigation help to comprehend that there is no significant relationship (long-run as well as short-run) in between AGRIDEX and NKRISHI indices in both Pre-COVID19 and During-COVID19 periods. The results concluded that there is not a big impact on both the indices after the COVID19 outbreak. The Results highlight the efficiency of both the markets, say, NKRISHI and AGRIDEX futures indices, and also establish relevant information for investors, policymakers, researchers and hedgers for future investments and further analysis. It contributes to the market efficiency literature for agricultural futures market.

Keywords: Agricultural Futures market, COVID19, Granger causality test, Johansen Cointegration test, Price Discovery, Unit Root test.
JEL Classification: G1, Q1, Q110, Q130

I. INTRODUCTION
Agricultural commodity trading is characteristically unsafe, attributable to the inelastic demand and supply, and over-reliance on weather conditions. India is one the significant players in the worldwide market as far as farming, utilization, creation and exchange of agricultural
commodities. Agricultural futures trading is a fundamental area of Indian Financial markets. It is generally perceived that an agricultural futures trading permits business hedgers, for example, agronomists and manufacturers to fence their product value chance. Since the merger of Forward Market Commission (FMC) with Securities exchange Board of India (SEBI) in 2015, agricultural futures markets have enrolled colossal development in trading volume, which has been credited to the accessibility of present day electronic platforms; thorough changes in exchanging, clearing and settlement frameworks including autonomous clearing, settlement ensured subsidize, and vigorous hazard the executives stages. Agricultural futures market trading helps to provide platforms for financial instruments to attain price innovation and better default price risk (Bhagwat and Maravi, 2016). Indian economy is based upon agriculture sector, where 52% workforce employed in agriculture and its products; and 35% of GDP (Gross Domestic Product) come from agriculture sector. So far the relationship between the Indian agricultural sector and COVID19 are concerned then the first quarter of 2020-2021 (From April to October) showed the positive 3.4% growth. Although, it was declined (from 5.4%) from the past last quarter (2019-2020) due to labour, production and supply chain constraints but agriculture was the only sector which shows positive growth.

The fundamental job or target of derivative is to shield farmers from the decrease of the estimation of their yields from least cost value level. Due to the risk of investment and the risk of volatility in the financial market, investors are more interested in portfolio management. In primary as well as secondary market, commodities are separate asset group for investors to investment and diversify their portfolio of investment as compared to old choices i.e. shares, bonds and portfolio (Kour and Anjum, 2013). Since the start of history, agribusiness has affected the life and culture of India. In India, the increase in derivative trading is found after early 2000s. National commodity and Derivative Exchange Limited (NCDEX) was established on April 23, 2003 under company Act, 1956. Presently, NCDEX regulated by SEBI under Securities Contracts Regulation (SCR) Act, 1956. The introduction of new and emerging India’s first return based tradable agricultural futures index (AGRIDEX) has increased a lot of consideration among investors, regulators and academicians. This index ensures diversification in selection of the agricultural commodities as constituents of the index. The top 10 constituted commodities are selected as per their liquidity position in NCDEX platform. The trading was initiated on AGRIDEX was from May 26, 2020. So, the underlying closing index prices (Before May 26, 2020) was calculated as per the real prices of underlying individual commodities. Besides this, study has used another agricultural futures index, say, NKRISHI which is also listed on NCDEX from 01 January 2007. This index is calculated as per real time prices of near-month futures contract. To analyse the efficiency and causal nexus between these two futures indices, one can examine the relationship and volatility characteristics between these markets. Present research work shows empirical past literature in Part 2 followed by data and research methodology in Part 3 subsequently followed by results and conclusion in Part 4 and Part 5 respectively.

2. LITERATURE REVIEW
In the area of Indian commodity market, presently the writing had covered the relationship among spot and futures prices (Chopra and Bessler, 2005; Easwaran and Ramasundaram, 2008;
Elumalai et al., 2009; Kumar and Pandey, 2011; Agrawal et al., 2019). Furthermore, present work outline the writing on the effect on volatility and the impact of financialisation on commodity market. However, there are very less studies on causal relationship in between agricultural commodity futures and spot markets of India. Chopra and Bessler (2005) examined cointegration relationship in the sample variable markets. Nearby futures contract market was found to be adjusting to shocks in the long run. So, empirical results showed the futures market as a price discovery vehicle. But the study was not able to find which future market (nearby or next to nearby) was the centre of price discovery. Easwaran and Ramasundaram (2008) showed that there were no price discoveries in agricultural futures markets. Results also showed that there was no relationship between both markets. Elumalai et al. (2009) showed the cointegration, unidirectional lead-lag and unidirectional short run relationship between both markets of pepper, guar seed and chana. Results shows dominance of futures market over spot market in long-run. Kumar and Pandey (2010) showed that volatility and trading volume were highly correlated. The trading volume was affected by overnight volatility but not the open interest. There was a positive impact of open interest on volume but a negative impact of volume existed on open interest. Kumar and Pandey (2011) revealed that the futures markets for all commodities co-integrated except soybean and corn which were traded in CBOT exchange. The Indian market was unidirectionally impacted by world markets and in case of return transmission there was a bidirectional relationship between MCX and LME markets. Mukherjee (2011) attempted to know the impact of futures trading on agricultural market of India. The empirical results showed significant lead of futures market for risk hedging and price discovery function. Sehgal et al. (2012) showed the long run equilibrium, bidirectional granger causality and informational efficiency in nine out of ten commodities. Malhotra and Sharma (2013) showed the long run comovement between spot and futures markets of guar seed and, futures market considered as hedging instrument. The futures market of guar seed led the spot market. Results showed that the error correction mechanism took place in both markets but the futures market made quicker adjustments as compared to spot market. Shakeel and Purankar (2014) revealed the long term relationship and bidirectional causality existed between the spot and futures series of all sample commodities. Vasantha and Mallikarjunappa (2015) showed that the spot market absorbed the information faster than future market and served as an efficient price discovery vehicle. Dhineshni and Dhandayuthapani (2016) showed the long run relationship and bidirectional causality between the futures and spot price series of all sample commodities. Results concluded that both spot and futures markets played dominant roles in price discovery process. Inani (2017) showed the cointegration of all the sample commodities. Further, futures market led the spot market for the price discovery function in case of six commodities out of ten. Agrawal et al. (2019) concluded that the agricultural futures commodities has great potential because of multiple e-platforms for trading, different lot sizes and tick sizes. Khalid and Jessica (2020) examined the long-run relationship between AGRIDEX and Wholesale Price Index (WPI) and found no cointegration between them. Manogna and Mishra (2020) examined the nine agricultural commodities and found that the futures market dominate the spot market in short-run as well as in long-run. Kumar et al. (2021) used AGRIDEX spot and futures indices to know the price discovery and lead-lag relationship in between 2016 to 2018. Results showed the dominance of futures market
over spot market in price discovery function. The above mentioned literature either considering the individual commodities or considering spot and futures market for checking the causal nexus but hardly any contribution came up with nexus of newly established agricultural future index (AGRIDEX) with the old benchmarking index (NKRISHI). The past literature on Indian agricultural market lead to capture research gap to design objectives of the present research article. The objectives of the present research articles are:

1. To know the existence of co-integration relationship in between NKRISHI and AGRIDEX futures indices during pre- and post-COVID19 outbreak in India.
2. To examine the Lead-Lag relationship in between NKRISHI and AGRIDEX futures indices during pre- and post-COVID19 outbreak in India.

3. DATA AND RESEARCH METHODOLOGY
The daily closing time-series data has been casted off ranging from April 01, 2018 to January 29, 2020 (Pre-COVID19) and from January 30, 2020 to October 11, 2021. The official website of the NCDEX (www.ncdex.com) has been considered for financial time-series data. To begin with, descriptive statistics has been calculated to know the data properties by taking the natural log for both the sample time-series. Then other econometric tests like Unit Root (ADF), Johansen co-integration and pairwise Granger Causality tests have been applied for further research work.

3.1. Unit Root Test
To investigate the stationarity, say, H0: Series has unit root in time series, present work employs the Augmented Dickey-Fuller (1979) test. A time series regression for testing unit root (ADF) is defined as follows:

\[ \Delta X_t = \delta X_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \]  

without drift  

(3.1)

\[ \Delta X_t = \beta_1 + \delta X_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \]  

with drift  

(3.2)

\[ \Delta X_t = \beta_1 + \beta_2 t + \delta X_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \]  

with drift and trend  

(3.3)

\[ \Delta = \]  

first difference operator. If \( \delta=0; \rho=1 \) which indicates the unit root in \( X_t \) series and again if \( \delta=0 \); then \( \Delta X_t = \mu_t \) and \( \mu_t \) is a white noise error term, thus, an random walk time series can become stationarity time series by using first difference. Where \( \epsilon_i \) is a pure random error term, and the hypothesis and critical statistical value for ADF is same as DF test. The lag order for \( \Delta X_t \) selected on the basis of statistical methods. The null hypothesis for the test of unit root set as \( \delta=0 \) (i.e. the series having unite root) where the alternative one is \( \delta<0 \) (i.e. series follow stationarity).

3.2. Johansen’s Co-integration test
To examine the long-term relationship, present research article uses the Johansen’s co-integration test by utilizing the procedure Johansen (1988, 1991) and Johansen and Juselius (1990). The order of integration must be same for both underlying series for employing the Johansen’s co-integration procedure. This test is also helpful to create error-correction based model to know the speed to market adjustment or recovery. To test cointegration between
NKRISHI and AGRIDEX in this present study, the two statistical tools, say, ‘trace statistics and eigen value’ given by Johansen (1988) has been considered for calculation co-integrating vectors. The lag-length is optimised as per the SIC (Schwarz Information Criteria). The trace- and max eigen- statistics has been represented as follows:

\[
\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^{n} \ln (1 - \hat{\lambda}_i) \quad (3.4)
\]

\[
\lambda_{\text{max}}(r, r+1) = -T \ln (1 - \hat{\lambda}_{r+1}) \quad (3.5)
\]

Here, T= Number of sample daily time-series data. \(\hat{\lambda}_i\) = calculated value of eigenvalue estimated from II matrix and \(n = 2\) (NKRISHI and AGRIDEX).

3.3 Granger Causality test
To examine the causal relationship, the Granger Causality test has been used. To begin with, the natural time-series of both (AGRIDEX and NKRISHI) has been converted into log-difference or log-return series then pairwise Engel and Granger, 1987 test has been employed. In simple terms, present methodology helps to identify which variable lead the market in short-run or which variable lag in the market in short-run. Schwarz Information Criterion has been followed to identify optimum lag. The following regression series has been used to examine causality between the AGRIDEX and NKRISHI futures indices time-series:

\[
A_t = \alpha_1 + \sum_{i=1}^{k} \alpha_{1i} A_{t-i} + \sum_{i=1}^{k} \beta_{1i} N_{t-i} + \varepsilon_{1t} \quad (3.6)
\]

\[
N_t = \alpha_2 + \sum_{i=1}^{k} \alpha_{2i} N_{t-i} + \sum_{i=1}^{k} \beta_{2i} A_{t-i} + \varepsilon_{2t} \quad (3.7)
\]

\(A_t\) and \(N_t\) are AGRIDEX and NKRISHI futures log-return series. \(\alpha_{1i}, \alpha_{2i}, \beta_{1i}\) and \(\beta_{2i}\) are the coefficient values of AGRIDEX and NKRISHI. \(\varepsilon_{1t}\) and \(\varepsilon_{2t}\) are pure white noise terms.

4. RESULTS AND INTERPRETATION

4.1 Summary statistics
The methods of central tendency, measures of dispersion and jarque-bera statistics are used to narrate data. Table 1 affirms two properties of the time series, volatility and non-normality. Results exhibit that the mean returns of both sample variables are positive (in both Pre- and Post-COVID19). It is marked that the Pre-COVID19 (Post-COVID19) NKRISHI prices are highly volatile ranging from minimum value of 7.9193 (7.9756) to the maximum value of 8.2033 (8.5173) with mean being 8.0677 (8.1969). Standard deviation of 0.0673 (0.1344) asserts instability in NKRISHI prices. On the other side, Pre-COVID19 (Post-COVID19) AGRIDEX for the period under consideration also evidences instability. Maximum value being 7.1461 (7.3163) and minimum being 6.8285 (6.8251) are exposed to their variability. It is
evident that the volatility (standard deviation) has been significantly increased from Pre-COVID19 to Post-COVID19 period. Both tests (skewness and kurtosis) violate normality assumptions of frequency distribution in Pre- and Post-COVID19 periods. It is apparent from the Table 1 that Jarque-Bera statistic further adds to the previous confirmation of non-normality. P-value being zero in both the series means rejection of null hypothesis of Jarque-Bera test at 1 percent significance level.

Table 1: Descriptive statistics

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Pre-COVID19</th>
<th></th>
<th>During-COVID19</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AGRIDEX</td>
<td>NKRISHI</td>
<td>AGRIDEX</td>
<td>NKRISHI</td>
</tr>
<tr>
<td>Mean</td>
<td>6.9402</td>
<td>8.0677</td>
<td>7.0431</td>
<td>8.1969</td>
</tr>
<tr>
<td>Median</td>
<td>6.9191</td>
<td>8.0561</td>
<td>7.0407</td>
<td>8.1846</td>
</tr>
<tr>
<td>Maximum</td>
<td>7.1461</td>
<td>8.2033</td>
<td>7.3163</td>
<td>8.5173</td>
</tr>
<tr>
<td>Minimum</td>
<td>6.8285</td>
<td>7.9193</td>
<td>6.8251</td>
<td>7.9756</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.0630</td>
<td>0.0673</td>
<td>0.1186</td>
<td>0.1344</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.7308</td>
<td>0.3138</td>
<td>0.6224</td>
<td>0.8596</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.8616</td>
<td>1.9931</td>
<td>2.6508</td>
<td>2.8976</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>84.4320</td>
<td>55.1349</td>
<td>25.4938</td>
<td>45.2421</td>
</tr>
<tr>
<td>Probability</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

4.2 Unit Root test
The results of unit root (ADF) test shows that the t-statistics values are more (less) than their absolute critical value in all the three test equations, say, with drift, with drift and trend, and no drift at first difference (at level) for both the sample futures index time-series in Pre- and Post-COVID19 periods (Table 2). Both time-series are found to be unified at first order i.e. I(1) and stationary at first difference. All empirical results guide us to implement further methodology to test relationship and volatility persistence.

Table 3: Result of Unit Root test (ADF)

<table>
<thead>
<tr>
<th>Variables</th>
<th>t-statistics (P-value)</th>
<th>t-statistics (P-value)</th>
<th>I(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At level</td>
<td>At first-difference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre-COVID19</td>
<td>During-COVID19</td>
<td>Pre-COVID19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I(n)</td>
</tr>
<tr>
<td></td>
<td>AGRIDEX</td>
<td>NKRISHI</td>
<td>AGRIDEX</td>
</tr>
<tr>
<td>With Drift</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGRIDEX</td>
<td>-1.7960 (0.3827)</td>
<td>0.0842 (0.9642)</td>
<td>-30.5875* (0.0000)</td>
</tr>
<tr>
<td>NKRISHI</td>
<td>-1.4910 (0.5379)</td>
<td>0.4198 (0.9836)</td>
<td>-30.4086* (0.0000)</td>
</tr>
</tbody>
</table>
4.3 Johansen’s Co-integration test

To resolve problem of over restrictions or under restrictions, optimum lag-value is assessed as per SIC (2). Trace- and maximal eigen- statistics are casted-off to identify number of cointegrating vectors. The results (Table 4) show no cointegration relationship between AGRIDEX and NKRISHI agriculture futures indices. Results concluded that both the index are working perfectly random and no proof of long-term connection found in between them. In addition to that, both indices does not reflect any price discovery function in long-run either in Pre-COVID19 time or in Post-COVID19 time.

<table>
<thead>
<tr>
<th>Agricultural Futures Indices</th>
<th>Data trend</th>
<th>None</th>
<th>None</th>
<th>Linear</th>
<th>Linear</th>
<th>Quadratic</th>
<th>No of Co-integration relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics ↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-COVID19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGRIDEX + NKRISHI</td>
<td>Trace</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Max-eigen</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>During-COVID19</td>
<td>Trace</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Max-eigen</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4.4 Granger Causality Test

Present article analyses the results of Granger causality test (Table 4) and show lead-lag relationship between two Agricultural futures indices, say, AGRIDEX and NKRISHI in short-run. Empirical results does not reject the null hypothesis ($H_0=\text{X does not granger causes Y}$) at any significant level. F- statistics values are found to be insignificant which show no Lead-Lag relationship in short-run (Both Pre- and Post-COVID19 periods) in underlying sample time-series.
Table 4: Pairwise Granger Causality Test

<table>
<thead>
<tr>
<th>Variables</th>
<th>F-Statistic</th>
<th>P-value</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-COVID19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGRIDEX + NKRISHI</td>
<td>0.3575</td>
<td>0.6995</td>
<td>H0= Not Rejected</td>
</tr>
<tr>
<td></td>
<td>0.6505</td>
<td>0.5221</td>
<td>H0= Not Rejected</td>
</tr>
<tr>
<td>During-COVID19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGRIDEX + NKRISHI</td>
<td>1.5195</td>
<td>0.2202</td>
<td>H0= Not Rejected</td>
</tr>
<tr>
<td></td>
<td>1.7039</td>
<td>0.1834</td>
<td>H0= Not Rejected</td>
</tr>
</tbody>
</table>

5. CONCLUSION
Volatility is always said to be the indicator of optimum trade-off between risk and return in the financial markets. Any unforeseen modification (increased or decreased) in randomness leads to disorganisation in the pricing of commodity prices. If someone is not having proper knowledge of volatility movements then one can not avail the arbitrage benefits. So, studying the causal relationship and price discovery function help in establishing prior financial behaviour patterns. The secondary data of two agricultural futures indices has been explored with respect to COVID19 outbreak. The conclusive results of both tests (for long-term and short-term) reveal that the both the agricultural benchmark indices (AGRIDEX and NKRISHI) of NCDEX moves randomly and does not follow each other. Study does not found any short-run as well as long-run cointegration and Lead-Lag relationship between them in both (Pre- and Post-COVID19 outbreak) periods. The result are found to be similar to Khalid and Jessica (2020) and Commodity Market outlook (2021) report. The agricultural prices are playing independently as compared to COVID19 outbreak. If any changes are found that are because of other factors like; demand, supply, production, labour, rainfall etc. It means there is no question of price discovery function or leading-lagging in these sample variables. This is happened because of one major reason that is AGRIDEX is return based index and NKRISHI is value weighted index. The second reason is both indices are future indices and investors cannot hold the long position in the market. They need to set off the contract before the expiry of the contract. The another reason could be the production volume because both indices considered the 50:50 weightage to the liquidity and production rate (5 year average) which eventually rebalanced every year in the beginning of the April. The Results highlight the relevant information for investors, policymakers, researchers and hedgers for future investments and further analysis. It contributes to the market efficiency literature for agricultural futures market. The present article is only limited to unit root testing, granger causality and cointegration testing but further research work will be extended by incorporating volatility characteristics and volatility forecasting.

REFERENCES


