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Exploring Price Trends and Market Integration of Coconut and Groundnut in Indian Oilseed Markets

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SUMMARY

Among the oilseed crops, Groundnut and Coconut prices are more unstable due to seasonality of production, perishable nature, production uncertainty etc. Lack of information on potential market as well as arrival and price behaviour of these oilseeds further worsen this situation of its growers. Since market integration helps in achieving price consistency and thus lead to marketing system efficiency, the present study examines the Market Integration of major oilseed crops–Coconut, and Groundnut–in India during the period of January 2013 to January 2024markets using Johansen's cointegration test and Granger Causality test. In this study to test the stationarity of the price seriesAugmented Dickey Fuller test was used. The outcomes of the study strongly supported the presence of co-integration and interdependence of the selected markets from the result of Johansen cointegration test and Market integration analysis across intrastate and interstate regions identified causal relationships, such as unidirectional causality between certain regions for Coconut and bidirectional causality for Groundnut. The study stressed the need for systematic research to address production constraints, technical advancements, and policy influences, to manage emerging challenges effectively.

Keywords: Cointegration; Oilseeds; Price transmission; Causality; Market integration.

1. INTRODUCTION

India's edible oil sector has been marred by persistent shortages largely attributed to insufficient domestic oilseed production. Despite a brief period of self-sufficiency during the "Yellow Revolution" in the early 1990s, the country's dependency on imports has escalated, even as it ranks among the top producers of oilseeds worldwide. Recent years have witnessed a marked increase in vegetable oil consumption, driven by both culinary and industrial demands, which has exacerbated the supply-demand imbalance (Keelery, 2024). As one of the world's leading importers of edible oils, India imports approximately 70% of its vegetable oil needs, with palm oil, soy oil, and sunflower oil primarily sourced from countries such as Indonesia, Malaysia, Argentina, Brazil, Russia, and Ukraine (*India: Oilseeds and Products Annual*, 2024). The domestic production figures are stark: India produces around 9.5 million metric tons of oilseeds, while consumption soars to approximately 22.5 million metric tons, resulting in a staggering import bill exceeding USD 13 billion. This situation contributes significantly to India's trade deficit in edible oils, contrasting sharply with its overall surplus in most other agricultural commodities (Bhosale, 2024).Regional disparities in oilseed yield further complicate the landscape. For instance, Tamil Nadu consistently records higher oilseed yields compared to the national average, indicating the potential for enhanced production if yields were optimized across the country. The Indian government, recognizing these challenges, is actively promoting initiatives to boost domestic oilseed production and reduce reliance on imports(*India: Oilseeds and Products Annual*, 2024). Such strategies include encouraging the cultivation of high-yield oilseed varieties and providing financial support for agricultural inputs, aimed at stabilizing prices and ensuring a steady supply of edible oils in the market (Minhas, 2024).

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Overall, revitalizing India's edible oil sector will require a comprehensive approach that addresses current inefficiencies, enhances cultivation practices, and leverages state-specific advantages, particularly in regions like Tamil Nadu. By implementing targeted policies and fostering innovation, India can work towards achieving greater self-sufficiency in its edible oil requirements, ultimately alleviating the pressures on its trade balance and improving food security. The objective is to assess the price transmission in oilseeds markets in India and Tamil Nadu.

2. MATERIALS AND METHODS

The study utilizes longitudinal price series data for groundnut and coconut sourced from secondary outlets, particularly the AGMARKNET website. The research focuses on specific intra-state markets within Tamil Nadu–such as Coconut markets in Vellore, Viruthachalam, Pollachi, and Avalpoondurai, and Groundnut markets in Thindivanam, Punjaipuliyampatti, Sevur, and Vellore. Additionally, inter-state markets, including Coconut markets from Tamil Nadu, Kerala, and Andhra Pradesh, as well as

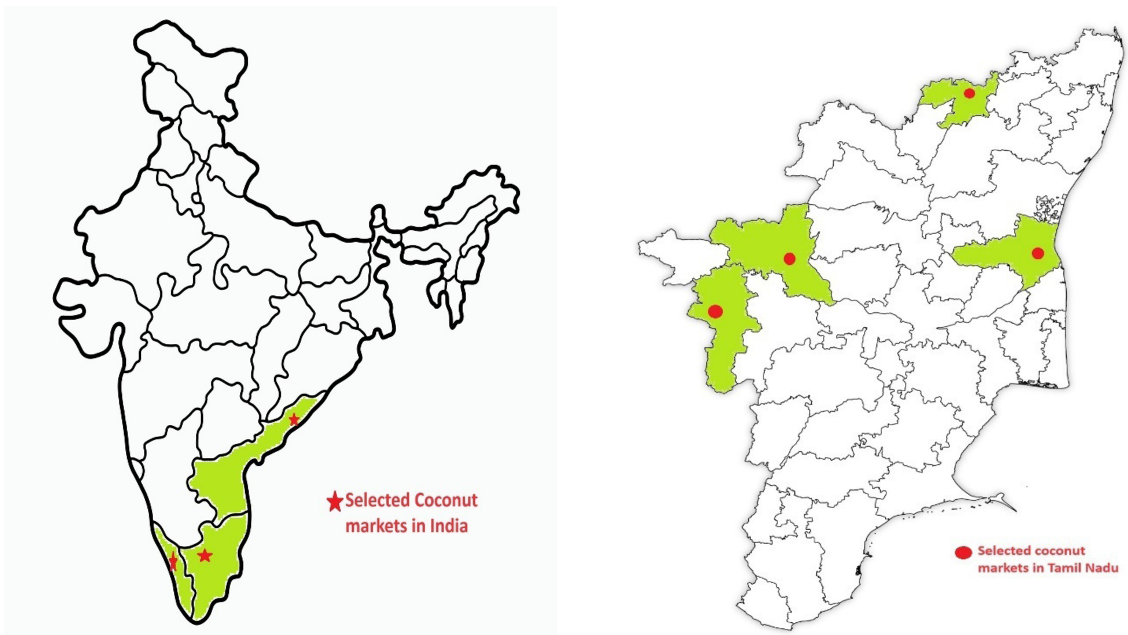

Fig. 1. Major Coconut markets selected in India and Tamil Nadu

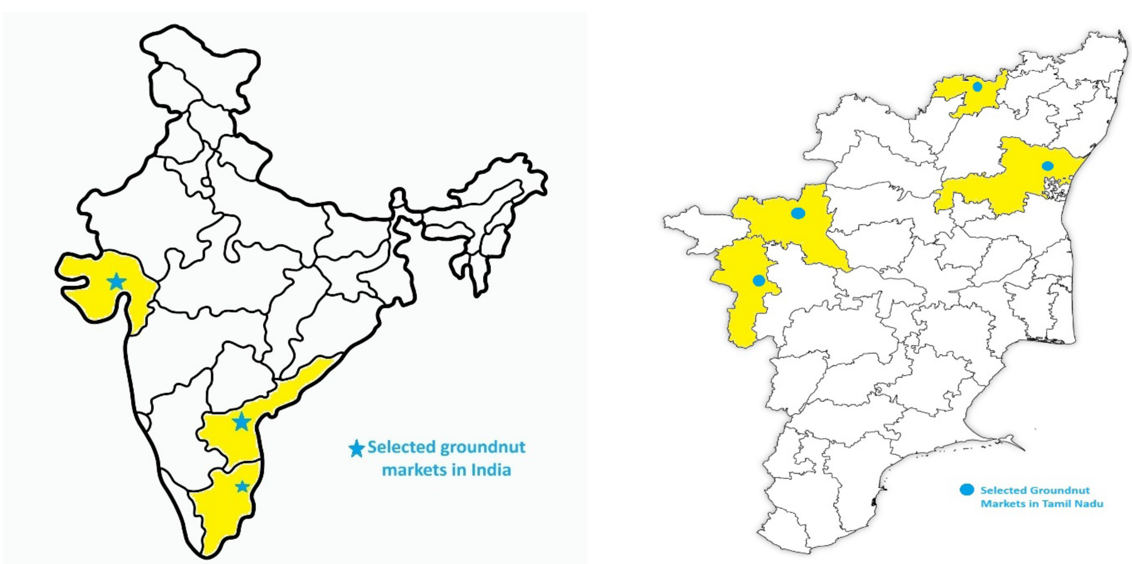

Fig. 2. Major groundnut markets selected in India and Tamil Nadu

Groundnut markets from Tamil Nadu, Gujarat, and Andhra Pradesh, are analyzed. This data encompasses the period from January 2013 to January 2024.

3. ESTIMATION AND ANALYTICAL METHODS

A framework for estimating and testing long-term equilibrium relationships between non-stationary integrated variables is provided by the concept of cointegration, which was first presented by Granger (1981), as well as the techniques for estimating a cointegrated relation or system put forth by Engle and Granger (1987) and Johansen (1988, 1991, 1995). Regressing time series data can produce inaccurate conclusions since they are frequently non-stationary. Testing for the existence of a unit root in each individual time series of the model is the first step in handling time series data. This is accomplished by using the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1981), both with and without a deterministic trend. In order to guarantee that serial correlation is absent, the number of lags in the ADF equation is selected using the Breusch-Godfrey statistic (Greene 2000, p. 541).

We used the Phillips-Peron unit root test to determine the degree of stationary of the variables used in the study in order to achieve the objectives of this paper. With the cointegration technique, the long-term relationship testing's goal cannot be achieved. In this work, the Johansen cointegration approach was used. The order of integration of the study's time series property was tested using the Phillip Peron (pp) test. According to Nyong (2003), the arbitrary use of lags in the Augmented Dickey Fuller (ADF) unit root test is replaced by the stationary test. The ADF test is improved by the Phillips-Perron test because it addresses the serial correlation in the error terms using non-parametric statistical techniques.

The time series data are assumed by the Johansen Cointegration Test to be non-stationary at their levels but to become stationary when they are differenced, i.e., integrated of order 1 (I(1)). It assumes constant parameters throughout and searches for linear, long-term equilibrium relationships between variables without structural breakdowns. Additionally, choosing a suitable lag length is necessary for the test; regularly distributed errors are favoured. In the meanwhile, the Granger Causality Test makes the assumption that one variable may predict another and that the data are stationary or can be made stationary. It assumes a linear relationship without instantaneous feedback between variables and is sensitive to lag length. Both tests, which focus on long-term relation for Johansen and short-term relation strength for Granger, depend on the absence of any missing factors that might bias the results.

When variables have a long-term relationship known as cointegration, there is always a chance that they will experience short-term disequilibrium (Gujarati, 2009). In this work, we generated an error correction model to reflect the short-run dynamics of our research series.

Johansen's methodology takes its starting point in the Vector Auto Regression (VAR) of order p given by:

$$Y_t = \mu + \lambda_1 Y_{t-1} + \lambda_2 Y_{t-2} + \dots\dots\dots + \lambda_k Y_{t-k} + e_t \quad (1)$$

This VAR (equation 2) can be re-written in dynamic form as:

$$\Delta Y_t = \mu + \Sigma^{\lambda} i \Delta Y_{t-i} + e_t \quad (2)$$

i=1

Where: Y_t is p×1 vector (many rows, one column) of integrated variables in a model, λ_k is a p×1 matrix of parameters, e_t is a px1 vector of stochastic term and p is the number of rows in a matrix (p×1 = total elements of column vector).

The matrix λ contains information about the long-run properties of the model. If λ has rank zero (r=0), where r is the number of cointegrating relationships, then the system is not cointegrated. If λ has rank p (r=p, i.e. full rank), all the variables in Y_t are stationary and are all cointegrated, indicating a long-run relationship between the research variables.

In the literature (Oseni and Onakoya, 2012), error correction term is defined by:

$$e_t = Y_t - \beta X_t, \quad (3)$$

Where: β is a cointegrating coefficient. (long-run parameter) and e_t is the error from a regression of Y_t on X_t. Then VECM is simply defined as:

$$\Delta Y_t = \alpha e_{t-1} + \gamma \Delta X_t + u_t \quad (4)$$

Where: u_t is a white noise error term, e_{t-1} is the equilibrium error (or disequilibrium term) occurred in the previous period, α and γ are short-run parameters. The VECM equation (4) simply says that ΔY_t can be explained by the lagged e_{t-1} and ΔX_t. If the latter is non-zero, then the model is out of equilibrium. In other word, if ΔX is zero and e_{t-1} is positive, then Y_{t-1} is above its equilibrium value and the value will start falling in the next period to correct the equilibrium error, hence the name VECM. Error correction approach is a means of reconciling the short-run behavior of an economic variable with its long-run behavior (Gujarati and Dawn, 2009).

The estimation of the unit root, cointegration and error correction models were carried out by the use of Econometric Views (7.0) software package.

4. GRANGER CAUSALITY TEST

Granger Causality Test Granger causality is a statistical concept of causality that is based on prediction. According to Granger causality, if a signal X "Granger causes"(or "G-causes") a signal Y, then present &past values of X may contain information that helps predict future Y. At the same time, it is important to note that Granger causality measures precedence and information content but does notby itself indicate causality. The causality test was attempted by the equation given below

$$\Delta Y_{it} = \beta_0 + \beta_1 Y_{(t-1)} + \beta_2 Y_{j(t-1)} + \sum_{k=1}^{m} \delta_k \Delta y_{i(t-k)} \sum_{h=1}^{n} \alpha_h \Delta y_{j(t-h)} + \varepsilon_{it} \quad (5)$$

Y_{it}= market 'i' at time 't'; Y_{jt} = market 'J' at time 't'

m &n = number of lags determined by SIC

The null hypothesis is that X does not Granger cause Y. Rejection of the null hypothesis that $\alpha h = 0$ where h =1, 2, 3, ..., nindicates that prices in market " j" Granger-cause prices in market "i". If prices in market "i" also Granger-cause prices in market "j", then prices are determined by a simultaneous feedback mechanism (SFM). This is the phenomenon of bi-directional causality. If the Granger causality runs one way, it is called unidirectional Granger-causality & the market which Granger causes the other is tagged the exogenous market.

5. RESULTS AND DISCUSSION

5.1 Stationarity Test

The results from various unit root tests indicate significant findings for coconut and groundnut markets. The Levin, Lin & Chu test suggests that all market series reject the null hypothesis of a common unit root, with p-values below 0.01. Similarly, the Im, Pesaran, and Shin W-stat test confirms rejection of the null hypothesis for coconut and groundnut markets, showing strong evidence against individual unit roots, particularly in the intra-state markets. Both the ADF and PP Fisher Chi-square tests further reinforce these findings, indicating that all market series are stationary.

This suggests that market prices may respond quickly to shocks, essential for effective market analysis and policy making.

5.2 AIC & SBC Creterion for Lag Length Determination

The cointegration analysis for coconut and groundnut markets, based on the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC), provides valuable insights into their long-term relationships. For the Coconut Inter-State series, the AIC values indicate a strong preference for lower values, suggesting a good fit of the model. Similarly, the Coconut Intra-State series shows optimal results at AIC = 62.724. The Groundnut Inter-State series also reflects consistent low AIC values, emphasizing the stability of its relationships. In the case of the Groundnut Intra-State series, the AIC values suggest a similar trend.

Table 1. Results of Unit root test for coconut and groundnut markets

Markets	**Coconut Inter-State**		**Coconut Intra-State**		**Groundnut Inter-State**		**Groundnut Intra-State**	
Test Type	**Statistic**	**Prob.**	**Statistic**	**Prob.**	**Statistic**	**Prob.**	**Statistic**	**Prob.**
Null: Common Unit Root Process								
*Levin, Lin & Chu t Test**	-2.463	0.007	-2.922	0.002	-2.351	0.009	-6.118	0.000
Null: Individual Unit Root Process								
Im, Pesaran and Shin W-stat Test	-4.338	0.000	-3.963	0.000	-2.134	0.016	-6.673	0.000
ADF–Fisher Chi-square Test	41.336	0.000	39.652	0.000	14.581	0.024	78.885	0.000
PP–Fisher Chi-square Test	43.275	0.000	39.807	0.000	24.555	0.000	85.678	0.000

Table 2. Results of AIC and SBC criterion for model fitting

Rank	Coconut Inter-State		Coconut Intra-State		Groundnut Inter-State		Groundnut Intra-State	
	AIC	SBC	AIC	SBC	AIC	SBC	AIC	SBC
0	46.661	47.520	63.091	63.467	47.839	**48.698**	68.927	**70.454**
1	**46.592**	**47.520**	62.850	63.413	47.717	48.744	68.798	70.516
2	46.635	47.781	**62.724**	63.476	**47.714**	48.800	68.824	70.733
3	46.740	48.029	62.766	63.705	47.753	48.921	68.878	70.978
4	NIL		62.901	**64.028**	NIL		**69.011**	71.302

These findings highlight the existence of cointegration among the price series, indicating potential long-term equilibrium relationships between coconut and groundnut markets.

5.3 Cointegration

Following the testing for unit roots and the determination of lag length, the next step is to assess whether the variables exhibit a common stochastic trend, indicating cointegration. Cointegration signifies a long-run relationship among non-stationary variables, whereby deviations from this long-run equilibrium are stationary. In this study, the Johansen multivariate cointegration procedure is employed to determine whether cointegration exists among the variables involved.

Table 3. Johansen Cointegration results for selected groundnut and coconut markets

Market Type	Trace Statistic	Eigen Value	Probability
Interstate Markets			
Groundnut	56.22**	0.26**	0.0002
Coconut	51.17**	0.31**	0.0006
Intrastate Markets			
Groundnut	105.39**	0.34**	0.0002
Coconut	86.44**	0.31**	0

**denotes rejection of the hypothesis at the 5% level.

The findings reveal the presence of one cointegrating equation at a 5% significance level, as indicated by the likelihood ratio tests. Specifically, the calculated trace statistic exceeds the critical value at the 95% confidence interval, confirming the existence of cointegration among the markets for groundnut and coconut. Additionally, the maximum eigenvalue test corroborates this outcome by rejecting the null hypothesis of no cointegrating vectors. Both tests effectively demonstrate the presence of one cointegrating equation at the 5% significance level.

6. GRANGER CAUSALITY TEST FOR DIFFERENT OILSEED CROPS

6.1 Coconut

Coconut market relationships exhibit a mix of bidirectional and unidirectional causality. The Granger causality test results, presented in Table 4, highlight bidirectional causality between the Avalpoondurai and Vellore markets, as well as between the Viruthachalam and Vellore markets. This indicates a mutual influence on price formation between these pairs.

Table 4. Results of granger causality test for coconut markets

Market Direction	F-statistic	Probability	Causality
Intrastate Markets			
Pollachi → Avalpoondurai	13.869	0.0003***	Reject H_0
Vellore → Avalpoondurai	19.085	0.0003***	Reject H_0
Virudhachalam ↔ Avalpoondhurai	11.959 / 6.287	0.0008***/ 0.0135**	Bidirectional
Pollachi → Virudhachalam	6.721	0.0108**	Reject H_0
Vellore → Virudhachalam	20.105	0.0002***	Reject H_0
Virudhachalam→ Vellore	2.674	0.1047*	Reject H_0
Interstate Markets			
Kasargode → Pollachi	3.135	0.0473**	Reject H_0
Pollachi → Srikakulam	6.577	0.0020***	Reject H_0
Kasargode → Srikakulam	7.474	0.0009***	Reject H_0

*(*** Significant at 1 percent level; ** Significant at 5 percent level; * Significant at 10 percent level; → indicates "Granger causes)*

Conversely, several unidirectional relationships are identified, including between Pollachi and Avalpoondurai, Vellore and Avalpoondurai, and Pollachi and Viruthachalam, wherein price movements in one market influence another without reciprocation. In interstate markets, unidirectional causality is evident between Kasargode and Pollachi, Pollachi and Srikakulam, and Kasargode and Srikakulam, again indicating that price changes in one market do not provide feedback to the originating market.

6.2 Groundnut

Granger causality is also estimated between pairs of domestic groundnut markets in India. Granger causality means the direction of price formation between markets and related spatial arbitrage, i.e., physical movement of the commodity to adjust for these prices differences.

Table 5. Results of granger causality test for groundnut markets

Market Direction	F-statistic	Probability	Causality
Intrastate Markets			
Erode → Coimbatore	1.953	0.1466	Reject H_0
Coimbatore → Erode	3.588	0.0309**	Reject H_0
Vellore → Erode	4.197	0.0174**	Reject H_0
Erode → Vellore	6.532	0.0021***	Reject H_0
Vellore → Thindivanam	7.843	0.0006***	Reject H_0
Thindivanam → Vellore	4.445	0.0139**	Reject H_0
Thindivanam → Erode	2.661	0.0742*	Reject H_0
Interstate Markets			
Adoni → Thindivanam	8.49	0.0004***	Reject H_0
Adoni → Gongal	2.499	0.0867*	Reject H_0

*(*** Significant at 1 percent level; ** Significant at 5 percent level; * Significant at 10 percent level; → indicates "Granger causes)*

The Granger causality test is utilized to analyze relationships between various domestic groundnut markets in India, focusing on the directional influence of prices and spatial arbitrage the physical movement of commodities to rectify price discrepancies. The results, summarized in Table 2, indicate bidirectional causality between three market pairs: Erode and Coimbatore, Vellore and Erode, and Vellore and Thindivanam. In these instances, price movements in one market influence the other, and vice versa.

In contrast, the Thindivanam market showcases a unidirectional causal relationship with the Erode marketprice changes in Thindivanam Granger-cause those in Erode, but Erode's prices do not feedback to the Thindivanam market. Furthermore, analysis of interstate markets reveals a unidirectional influence from Adoni to both Thindivanam and Gondal, suggesting that the Adoni market drives price formation in these locations without reciprocal feedback.

7. CONCLUSION

This study analyzed the market integration of selected oilseed crops in intrastate (Coconut-Vellore, Viruthachalam, Pollachi (Coimbatore), Avalpoondurai (Erode), and Groundnut- Thindivanam, Punjaipuliyampatti (Erode), Sevur (Coimbatore), Vellore) and interstate (Coconut- Tamil Nadu, Kerala, Andhra Pradesh and Groundnut-Tamil Nadu, Gujarat, Andhra Pradesh) Johansen cointegration were used. The data on prices were found to non-stationary are converted to stationary using differencing and the lag length is determined using AIC, SBC criterion. Specifically, the Johansen cointegration framework has been applied to analyze the interconnectedness of price movements across coconut and groundnut markets. The analysis establishes that the price series for oilseed crops are largely non-stationary; appropriate differencing was employed to achieve stationarity, accommodating for seasonal variations. The results of the Granger causality tests substantiate the presence of complex interrelationships among the markets. Notably, a unidirectional causality was found between several key markets, revealing critical insights into the dynamics of price formation and market behaviour.

Furthermore, the increasing production of oilseeds necessitates comprehensive research to address challenges such as crop management and the uncertainties associated with investment returns, particularly in rainfed agricultural areas. A deeper investigation into the constraints hindering production, alongside a thorough analysis of both domestic and international policy frameworks, is essential to identify gaps and develop strategies that influence overall market demand and supply effectively. In conclusion, this study highlights the critical need for adaptive policy measures and innovative practices that transcend traditional decision-making boundaries, ultimately enhancing the resilience and sustainability of the oilseed market in Tamil Nadu.

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