Original Research Article

Analysing Market Integration and Causality of Oilseed Crops: Key Insights and Challenges in Major Tamil Nadu Markets and Interstate Regions of India

Abstract

Oilseed crops like Sesame, Groundnut, and Coconut experience significant price fluctuations due to factors like seasonal production patterns, their perishable nature, and uncertainties mentioned the uncertainties?? in output. The which?situation for farmers is further complicated by a lack of information about market conditions, including the timing of arrivals and pricestrends. Market integration, which helps stabilize prices and improve the efficiency of the marketing system, is a key factor in addressing these issues-. This study focuses on analysing the market integration of major oilseed crops— Coconut- is not oil seed crop its Plantation crop, Sesame, and Groundnut in India from January 2013 to January 2024. Johansen's cointegration test and the Granger Causality test were applied to examine how prices in different markets are influence one another related-. The stationarity of the pricesseries was first tested using the Augmented Dickey-Fuller test. The results confirmed that the prices are cointegratedmarkets are co-integrated, showing a strong interdependence between them. The analysis also revealed causal relationships between regions, such as unidirectional causality in the case of Coconut and bidirectional causality for Sesame and Groundnut. The findings underscore the importance of further research to address production challenges, improve technical methods, and develop informed policies to manage the issues faced by oilseed crop growing farmers. This will help overcome obstacles in to production and ensure a more efficient marketing system.

Keywords:*Agmarknet, did not used as key word !!Groundnut, Coconut, Sesame, Granger Causality, Market integration*

1. INTRODUCTION

India has been grappling with a chronic shortage of edible oils due to insufficient domestic oilseeds crop production, even though it briefly achieved self-sufficiency during the "Yellow Revolution" in the early 1990s. The consumption of vegetable oil has significantly increased in recent years for both food and industrial uses, widening the gap between supply and demand. Despite being the fourth largest producer of oilseeds worldwide, India is one of the major importers of edible oils.Over the past thirty years, India's oilseed sector has seen considerable fluctuations, transitioning from a net importer in the 1980s to a short-lived net exporter status in 1989-90, before returning to substantial imports by 1997-98. This shift necessitated a large foreign exchange expenditure to satisfy domestic needs.In India, and Tamil Nadu inparticularly, faces a significant challenge in predicting edible oilseed crop prices. Even though India is the fifth largest vegetable oil economy in the worldclarify ??with above sentence, it heavily depends on imports, fulfilling only 55-60% of its domestic demand. Given that 72% of oilseed cultivation is rainfed and high-risk, there is an urgent need to address production, marketing, and price risks to boost productivity and lessenlesser reliance on imports. On a global scale, oilseed production, led by soybeans, is on the rise, while other oilseeds are declining. In 2021-22, total production reached 632.86 million metric tons. India is the second largest producer of oilseeds after food grains, but there is a significant gap between domestic production (9.5 million tonnes) and consumption (22.5 million tonnes), leading to a USD 13.5 billion import bill.

This imbalance contributes to India's trade deficit, especially in edible oils, which contrasts with its surplus in most other agricultural products. The trade deficit from edible oil imports jumped from USD 8 billion before the pandemic to USD 13 billion in Jan-Oct 2021. The share of edible oil in the total trade deficit nearly doubled from 5.9% in Jan-Oct 2019 to 10% in the same period in 2021. The yield of oilseeds in India is not consistent across the country. In the 2018-19 period, Tamil Nadu recorded the highest yield at 2,310 kg per hectare for which crop??, while the average yield for all of India was only 1,265 kg per hectare mention the crop name . The government of Tamil Nadu was recognized for its oilseed production and received the Krishi Karman award from the Centre from which department or Ministry specify ?in 2019. If the average yield in India could be increased to match that of Tamil Nadu, the total oilseed production in the country would see an increase of 82%. Tamil Nadu is a significant contributor to this sector, with 40% of the total area under groundnut crop prof of data must needed and reviewed. The state is also a leading exporter of coconut byproducts such as activated carbon, coconut oil, and coconut shell charcoal.The Tamil Nadu government is promoting the cultivation of high-yield oilseed crops like groundnut, gingelly, sunflower, soybean, and castor. They are encouraging cluster demonstrations and the cultivation of oilseeds in rice-fallow conditions. Name of the scheme This scheme will be implemented across all districts of Tamil Nadu, covering an area of 2.5 lakh acres with an outlay of ₹45 crore, funded by both the Union and State governments. To increase the cultivation area and productivity of gingelly in districts declared as the 'Oilseed Zone', Rs. 3 crores would be allocated to provide subsidies for inputs and harvesting charges for 25,000 acres. The objective is to study the growth and instability of the area, production, and

productivity of the oilseed crop in India, assess the price transmission in oilseeds markets in India and Tamil Nadu, and forecast the price of edible oilseeds crop in Tamil Nadu.

2. MATERIALS AND METHODS

The longitudinal wholesale price series data of sesame, groundnut and coconut for the current study is collected from secondary source like AGMARKNET.In Tamil Nadu the major markets hoe do consider them as major market ? have you work out any prof for it pls specify? of coconut are Vellore, Viruthachalam (Cuddalore), Avalpoondurai (Erode) andPollachi (Coimbatore).For Sesame, the markets selected are Sivagiri (Erode), Thindivanam (Villupuram), Viruthachalam (Cuddalore) andAttur (Salem); in case of Groundnut, markets includeThindivanam (Villupuram), Punjaipuliyampatti(Erode), Sevur(Coimbatore) andVellore. The inter-state markets for Coconut are Pollachi (Tamil Nadu), Kozhikode (Kerala), Srikakulam (Andhra Pradesh); for Sesame the selected markets are Thindivanam (Tamil Nadu),Kalbargi(Karnataka), Gondal (Gujarat); the major markets for Groundnut are Thindivanam (Tamil Nadu), Amreli (Gujarat), Adoni (Andhra Pradesh) were selected for the period from January 2013 to January 2024.Pls specify the reason for selection of state and major market?

Figure 1. Selected markets for sesame, coconut and groundnut crops in India.

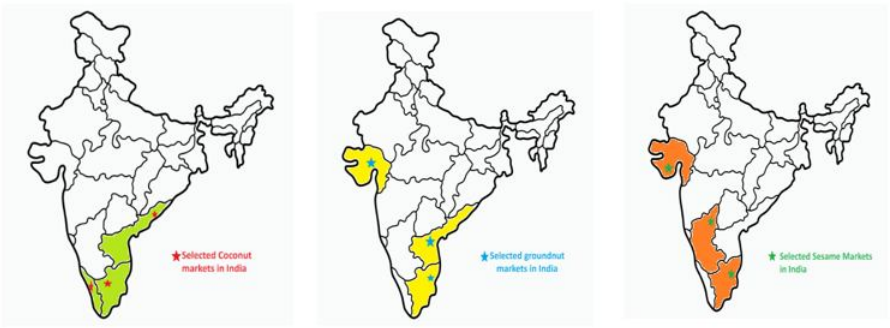
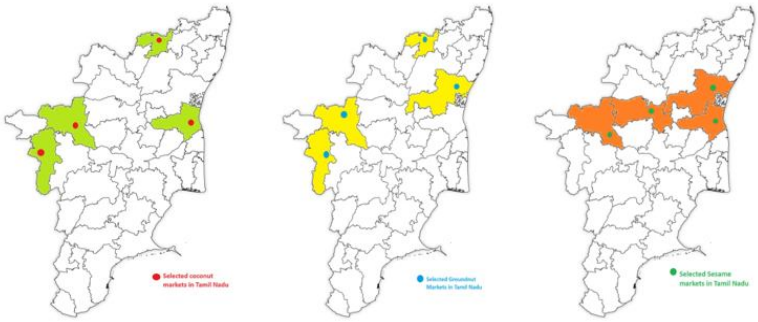


Figure 2. Selected markets for sesame, coconut and groundnut crops in Tamil Nadu.



2.1 Johansen Cointegration Test

The concept of cointegration, introduced by Granger (1981), along with the methods for estimating a cointegrated relation or system proposed by Engle and Granger (1987) and Johansen (1988, 1991, 1995), provide a framework for estimating and testing for long-term equilibrium relationships between non-stationary integrated variables. Time series data are often non-stationary, and if regressed, can yield misleading results. The first step in dealing with time series data is to test for the presence of a unit root in each individual time series of the model. The Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1981), both with and without a deterministic trend, is used for this purpose. The number of lags in the ADF equation is chosen to ensure that serial correlation is absent, using the Breusch-Godfrey statistic (Greene 2000, p. 541).

The ADF equation is estimated using the Ordinary Least Squares (OLS) method as follows:

$$\Delta P_t = a_3 + b_3 t + (\phi_3 - 1)P_{t-1} + \sum \theta_t \Delta P_{t-1} + \mu_t (1)$$

Here, Pt is the series under investigation and μt is the error term. If two series are integrated of the same order, Johansen's (1988) procedure can be used to test for the long-term relationship between them.

The approach adopted in this paper is based on Sims' (1980) methodology of a general unrestricted Vector Autoregressive (VAR) model where, unlike single equation methods, the exogeneity of one price is not imposed ex ante. Long-run market integration is examined using Johansen's cointegration procedure. The VAR model is represented as:

$$X_t = \delta + A1X_{t-1} + A2X_{t-2} + \ldots + A_{p-1}X_{t-p+1} + \varepsilon t (2)$$

In this model, Xt is an (n×1) vector of endogenous variables, δ is an (n×1) vector of parameters, Ai represents (n×n) matrices of parameters, and εt is an (n×1) vector of random variables. The price series for the ten major mango markets were endogenous variables and as such no exogenous variable was used.To test the hypothesis of integration and cointegration in equation (2), it is transformed into its Vector Error Correction form:

$$\Delta Xt = \mu + \Gamma 1 \Delta Xt-1 + \Gamma 2 \Delta Xt-2 + \ldots + \Gamma k-1 \Delta Xt-k+1 + \pi Xt-k + \varepsilon t (3)$$

Here, Xt= [P1t, P2t]′ is a vector of endogenous variables, which are I(1), ΔXt=Xt−Xt−1, μ is a (2×1) vector of parameters, Γ1,…,Γk+1 and π are (2×2) matrices of parameters.

2.2 Granger causality Test

To test the pattern of causality between two markets, F test was used. The null hypothesis Hp: The lagged X does not granger Y and the Alternative hypothesis HI: The lagged X granger cause Y.

We can test for the absence of Granger causality by estimating the following VAR model:

$yt = \alpha 0 + \alpha 1 yt-1 + \cdots\cdots\cdots + \alpha p yt-p + \beta 1 xt-1 + \cdots\cdots + \beta p xt-p + \epsilon t$

$xt = \alpha 0 + \alpha 1 xt-1 + \cdots\cdots\cdots + \alpha p xt-p + \beta 1 yt-1 + \cdots\cdots + \beta p yt-p +$ ut

For all possible pairs of (x, y) series in the group.

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.

Where is ADF Test methodology ????

3. RESULTS AND DISCUSSION

3.1 Cointegration

After testing the unit root and lag length is determined, the next step is to find out whether the variables share a common stochastic trend, i.e. to test whether two or more variables are co integrated or not. The concept of cointegration implies that if there is a long run relationship between two or more non-stationary variables, deviations from this long-run path are stationary. Johansen's cointegration multivariate procedure is used to establish whether the variables are co-integrated in the long run. The result of likelihood ratio indicates one co-integrating equations at 5% significance level. In other words, it accepts alternative hypothesis of having one co-integrating vector. Since the calculated trace statistic is greater than the 95% critical value of the trace statistic value, it is possible of cointegration exist between the markets for groundnut, sesame and coconut. The result for maximum Eigen value test confirms the rejection of the null hypothesis; i.e., no co-integrated vectors. Therefore, both Trace statistic value and maximum Eigen value indicate that there are one co-integrating equations at 5% significance levels as shown in Table 1.

Table 1 Estimates of Johansen Cointegration Test for oilseeds crop

Markets	Hypothesised No. of CE	Trace Statistic	Eigen Value	Prob
Groundnut (Interstate)	None**	56.22**	0.26**	0.0002
	At most 1	20.77	0.15	0.0073
Groundnut (Intrastate)	None**	105.39**	0.34**	0.0002
	At most 1	55.05	0.22	0.0052

Sesame (Interstate)	None**	41.12	0.19	0.0102
	At most 1	15.64	0.11	0.1916
Sesame (Intrastate)	None**	0.15**	0.17**	0.0042
	At most 1	19.91	23.31	0.5048
Coconut (Interstate)	None**	51.17**	0.31**	0.0006
	At most 1	6.92	0.05	0.2570
Coconut (Intrastate)	None**	86.44**	0.31**	0.0000
	At most 1	41.93	0.22	0.0001

**denotesrejectionofthehypothesisatthe5%level

Results from table~~Table 1~~ presents the estimates of Johansen's Cointegration Test for the selected oilseed markets, focusing on both interstate and intrastate regions for Groundnut, Sesame, and Coconut. The results indicate that for Groundnut, both the interstate and intrastate markets exhibit significant cointegration, as seen by the rejection of the null hypothesis at the 5% Vellore, with trace statistics of 56.22 and 105.39, respectively. Similarly, Coconut markets, both interstate and intrastate, also show strong evidence of cointegration, with significant trace statistics of 51.17 and 86.44. In the case of Sesame, the intrastate markets demonstrate cointegration, while the interstate markets show weaker evidence, with the interstate markets' trace statistic of 41.12 not reaching the same level of significance as other crops. Overall, these findings suggest a strong interdependence and long-term equilibrium relationship among the selected oilseed markets, particularly in Groundnut and Coconut.

3.2 Granger Causality Test for Different Oilseed Crops

3.2.1 Groundnut

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

Table 2 Results of granger causality test ground nut

	F- statistics	Prob.	Reject H0
Groundnut Intra-state			
ERODE does not Granger Cause COIMBATORE	1.95300	0.1466	Reject
COIMBATORE does not Granger Cause ERODE	3.58753	0.0309	Reject
THINDIVANAM does not Granger Cause COIMBATORE	1.77698	0.1738	Accept
COIMBATORE does not Granger Cause THINDIVANAM	0.05276	0.9486	Accept
VELLORE does not Granger Cause COIMBATORE	1.99314	0.1410	Accept

COIMBATORE does not Granger Cause VELLORE	0.13922	0.8702	Accept
THINDIVANAM does not Granger Cause ERODE	2.66119	0.0742	Reject
ERODE does not Granger Cause THINDIVANAM	1.95029	0.1470	Accept
VELLORE does not Granger Cause ERODE	4.19715	0.0174	Reject
ERODE does not Granger Cause VELLORE	653188	0.0021	Reject
VELLORE does not Granger Cause THINDIVANAM	7.84274	0.0006	Reject
THINDIVANAM does not Granger Cause VELLORE	4.44510	0.0139	Reject
Groundnut Inter-state			
ADONI does not Granger Cause THINDIVANAM	8.49023	0.0004	Reject
THINDIVANAM does not Granger Cause ADONI	1.35353	0.2625	Accept
GONDAL does not Granger Cause THINDIVANAM	1.58558	0.2094	Accept
THINDIVANAM does not Granger Cause GONDAL	1.89924	0.1544	Accept
GONDAL does not Granger Cause ADONI	0.72044	0.4888	Accept
ADONI does not Granger Cause GONDAL	2.49902	0.0867	Reject

~~Table 2 displays the results of the Granger causality test for both intrastate and interstate Groundnut markets. In the intrastate markets, there is significant bidirectional causality between., Erode and Coimbatore market, as the null hypothesis is rejected for both directions with p-values of 0.0309 and 0.1466. Additionally, bidirectional causality is observed between Vellore and Thindivanam market with significant p-values of 0.0006 and 0.0139. Other relationships, such as between Vellore and Erode market, also show unidirectional causality, with Erode Granger-causing Vellore (p = 0.0021). Conversely, no causality is observed between certain market pairs, such as between Coimbatore and Thindivanam or Vellore and Coimbatore, where the null hypothesis is accepted.~~Results are not clear pls re check with data and mention level of significance ??

~~In the interstate markets, the Adoni market Granger-causes the Thindivanam market (p = 0.0004), while the reverse relationship is not significant, indicating unidirectional causality. Similarly, Adoni Granger-causes Gondal (p = 0.0867), but the Gondal market does not significantly influence Adoni. These results highlight key directional relationships in price movements between specific markets, with notable bidirectional and unidirectional influences within and between states~~. Not clear about the results first state what is the meaning of Unidirectional flow and bi-directional flow pls refer some related articles for reference !

3.2.2Sesame

Table 3 provides the Granger causality test results for Sesame markets, both within (intrastate) and across (interstate) states. The test identifies significant unidirectional and bidirectional causality between markets, indicating how price movements in one market can influence others. These relationships highlight key patterns of market integration and interdependence among Sesame-growing regions.

Table 3 Results of granger causality test sesame

	F- statistics	Prob.	Reject H0
SESAME INTRA STATE			
ERODE does not Granger Cause CUDDALORE	1.91031	0.1528	Accept
CUDDALORE does not Granger Cause ERODE	4.36727	0.0149	Reject
SALEM does not Granger Cause CUDDALORE	1.28630	0.2803	Accept
CUDDALORE does not Granger Cause SALEM	5.83929	0.0039	Reject
VILLUPURAM does not Granger Cause CUDDALORE	4.85845	0.0095	Reject
CUDDALORE does not Granger Cause VILLUPURAM	7.68602	0.0007	Reject
SALEM does not Granger Cause ERODE	0.83254	0.4376	Accept
ERODE does not Granger Cause SALEM	6.97344	0.0014	Reject
VILLUPURAM does not Granger Cause ERODE	3.75925	0.0263	Reject
ERODE does not Granger Cause VILLUPURAM	7.04133	0.0013	Reject
VILLUPURAM does not Granger Cause SALEM	7.68939	0.0007	Reject
SALEM does not Granger Cause VILLUPURAM	1.22782	0.2968	Accept
SESAME INTER STATE			
AMRELI does not Granger Cause VILLUPURAM	2.36342	0.0751	Accept
VILLUPURAM does not Granger Cause AMRELI	1.95987	0.1242	Accept
KULBARNI does not Granger Cause VILLUPURAM	2.72645	0.0476	Reject
VILLUPURAM does not Granger Cause KULBARNI	1.7919	0.1529	Accept
KULBARNI does not Granger Cause AMRELI	1.75337	0.1604	Accept
AMRELI does not Granger Cause KULBARNI	3.89406	0.0109	Reject

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Table 3 summarizes the Granger causality test results for Sesame markets at both the intrastate and interstate levels. In the intrastate markets, significant unidirectional causality is observed between Cuddalore and several markets. For instance, Cuddalore Granger-causes both Salem (p = 0.0039) and Villupuram (p = 0.0007), while Erode Granger-causes Salem (p = 0.0014). Additionally, there is bidirectional causality between Erode and Villupuram, with both directions showing significant p-values (p = 0.0013 and p = 0.0263). However, no causality was detected between certain market pairs, such as between Erode and Cuddalore (p = 0.1528), and between Salem and Villupuram in one direction (p = 0.2968).Mention the level of significance for acceptance

In the interstate markets, the relationship between Villupuram and Kulbarni shows unidirectional causality, with Kulbarni Granger-causing Villupuram (p = 0.0476), but the reverse is not true (p = 0.1529). Additionally, Amreli Granger-causes Kulbarni (p = 0.0109), while no causality was detected between Amreli and Villupuram in either direction (p = 0.0751 and p = 0.1242). These findings highlight important interdependencies and directional price influences within both intrastate and interstate Sesame markets.

3.2.3 Coconut

Table 4 illustrates the results of the Granger causality test for coconut markets at both intrastate and interstate levels. The findings reveal bidirectional causality in two instances: between the Avalpoondurai and Vellore markets, and between the Viruthachalam and Vellore markets, indicating mutual price influence and feedback between these markets. Additionally, unidirectional relationships are identified between the Pollachi and Avalpoondurai markets, as well as between Vellore and Avalpoondurai, and Pollachi and Viruthachalam. The absence of causality in other market pairs suggests limited price interdependence across these regions.

Table 4 Results of granger causality test coconut

Null Hypothesis	F- statistics	Prob.	Reject H0
COCONUT INTRA STATE			
POLLACHIdoes not Granger Cause AVALPOONDURAI	13.8692	0.0003	Reject
AVALPOONDURAI does not Granger Cause POLLACHI	0.30572	0.5814	Accept
VIRUTHACHALAM does not Granger Cause AVALPOONDURAI	19.0847	0.0003	Reject
AVALPOONDURAI does not Granger Cause VIRUTHACHALAM	2.42311	0.1223	Accept
VIRUTHACHALAMdoes not Granger Cause AVALPOONDURAI	11.9594	0.0008	Reject
AVALPOONDURAIdoes not Granger Cause VIRUTHACHALAM	6.28742	0.0135	Reject
VELLOREdoes not Granger Cause POLLACHI	0.92875	0.3372	Accept
POLLACHIdoes not Granger Cause VELLORE	1.83389	0.1783	Accept
VIRUTHACHALAMdoes not Granger CausePOLLACHI	2.35363	0.1277	Accept
POLLACHIdoes not Granger Cause VIRUTHACHALAM	6.72100	0.0108	Reject
VIRUTHACHALAMdoes not Granger Cause VELLORE	2.67350	0.1047	Reject
VELLORE does not Granger Cause VIRUTHACHALAM	20.1052	0.0002	Reject
COCONUT INTER STATE			
KASARGODE does not Granger Cause POLLACHI	3.13486	0.0473	Reject
POLLACHI does not Granger Cause KASARGODE	2.49037	0.0874	Accept
SRIKAKULAM does not Granger Cause POLLACHI	0.30820	0.7354	Accept
POLLACHI does not Granger Cause SRIKAKULAM	6.57657	0.0020	Reject
SRIKAKULAM does not Granger Cause KASARGODE	1.70675	0.1861	Accept
KASARGODE does not Granger Cause SRIKAKULAM	7.47403	0.0009	Reject

Table 4 presents the Granger causality test results for coconut markets, both within and across states. The test shows that in some market pairs, price movements in one market directly influence the other, while in others, no significant relationship exists.Forinstance, there is a bidirectional

causality between the Avalpoondurai and Vellore markets, as well as between the Viruthachalam and Vellore markets. This means that prices in these markets affect each other mutually. If prices change in one market, the other responds, and vice versa. On the other hand, there is unidirectional causality between Pollachi and Avalpoondurai, as well as between Vellore and Avalpoondurai, and Pollachi and Viruthachalam. In these cases, price changes in one market affect the other, but there is no feedback from the second market to the first. Lastly, in some market pairs, like Vellore and Pollachi, there is no significant causal relationship, indicating that price movements in these markets are independent of each other. Similarly, interstate markets like Kasargode and Pollachi and Kasargode and Srikakulam show either unidirectional or no causality, meaning price influence between these markets is either one-sided or absent altogether. Mention the level of significance

4. CONCLUSION

This study analysed the market integration of selected oilseed crops in intrastate (Coconut-Vellore, Viruthachalam, Pollach, Avalpoondurai, Sesame-Sivagiri, Thindivanam, Viruthachalam, Attur) and Groundnut- Thindivanam, Punjaipuliyampatti, Sevur, Vellore) and interstate (Coconut- Tamil Nadu, Kerala, AP and Sesame-Tamil Nadu, Karnataka, Gujarat and Groundnut-Tamil Nadu, Gujarat, AP) 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 explain in methodology

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The Granger Causality for coconut resulted that there is unidirectional causality between Viruthachalam to Vellore, Pollachi to Viruthachalam, Pollachi to Avalpoondurai, Viruthachalam to Vellore, Vellore to Avalpondurai. For Sesame there is bidirectional causality between Sivagiri and Thindivanam; Viruthachalam and Thidivanam, unidirectional causality between Viruthachalam to Attur, Viruthachalam to Sivagiri, Thidivanam to Attur. Groundnut showed bidirectional causality between Vellore and Thindivanam, Punjaipuliyampatti and Vellore, whereas unidirectional causality between Thindivanam to Punjaipuliyampatti, Sevur to Punjaipuliyampatti. In interstate causality there is a Unidirectional causality between Tamil Nadu to Andra Pradesh, Kerala to Andra Pradesh and Kerala to Tamil Nadu for coconut. In case of sesame there is a Unidirectional causality between Karnataka to Tamil Nadu, Gujarat to Karnataka, Gujarat to Tamil Nadu. Groundnut showed bidirectional causality between Tamil Nadu and Gujarat and unidirectional causality between Andra Pradesh to Tamil Nadu, Andra Pradesh to Gujarat. The magnitude of increase in oilseeds production calls for the systematic research in this area. Technical breakthrough, crop management and uncertainty in the returns to investment ensuring from the cultivation in rainfed areas are the factors that obstructs the production process. A meticulous study on constraints that obstruct the production process can help in understanding the problems and bringing the new technology. There is a need to address new challenges that transcend the traditional decision-making horizons of producers, consumers and policymakers. Cite the suitable refrence where evr need in introduction, Methodology and results discussionsit is most important !

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