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MARKET INTEGRATION OF SPOT AND FUTURES PRICES FOR MAJOR COTTON COMMODITIES IN INDIA

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ABSTRACT--

This study investigates the performance and price discovery functions of spot and futures markets for cotton in India, specifically focusing on cotton fibre and cottonseed oilcake traded on the National Commodity and Derivatives Exchange (NCDEX). Using time-series data from 2010–2018, the research assesses market efficiency through econometric tools including cointegration tests, Vector Error Correction Models (VECM), Granger causality, and variance decomposition. The results show a long-run equilibrium relationship between spot and futures prices; however, the futures market does not lead the spot market, as evidenced by unidirectional causality from spot to futures prices. The study concludes that while cotton futures contracts have some predictive power, they fall short in fully integrating price information and performing effective risk management. Policy measures such as enhancing farmer participation, improving grading systems, and integrating e-NAM with futures trading are recommended to strengthen market efficiency.

KEYWORDS: *Price Discovery, Cointegration, Granger Causality, Cotton Commodities, India.* -------------

INTRODUCTION

Persistence of price instability of agricultural commodities along with stakeholders' direct exposure to such fluctuations remains major concerns for policymakers in India. The dimension of the problem warrants additional attention in case of agricultural products since unlike others, these carry added risk of witnessing seasonal fluctuations and attracting lower prices during harvest season. Changing economic environment, changing demand and supply position of agricultural commodities and growing international competitions require wider roles for futures markets in India (Easwaran and Ramasundaram, 2008). Under such circumstances, a wider role for futures markets to ensure stability is required as an efficient risk minimizing tool. In addition, a major problem with operationalization of futures market for agriculture in India is its unorganized character. In addition, risks associated with agricultural commodities market tend to vary from commodity to commodity avoiding tractable solutions. Therefore, demand for commodity-wise research on the underlying fundamentals which govern demand, supply and pricing behavior poses a surmountable task in searching for a viable option (Elumalai *et al*., 2009, and Kar, 2021).

Cotton is one of the most widely traded commodities both in spot and futures markets in India. However, uncertainty and volatility in cotton prices remain at elevated levels. Annualized volatility of cotton prices was as high as 20 per cent, on average (Sood, 2023). A part of the reason for such high volatility is the international nature of this agri-commodity, whose 32 per cent of world production enters international trade every year. This means that the fundamental factors in multiple countries, not to mention the dynamics of international trade, go on to determine the prices of cotton in India (as elsewhere). In fact, four countries – India, China, United States and Pakistan – account for about 70 per cent of the world production, which indicates the extent to which factors originating in multiple countries affect cotton prices, or make them volatile (USDA, 2024). Thereby, commodity derivatives markets serve as an important platform for bringing stability in the commodity markets by providing stakeholders with the avenue for risk management. In the context of the cotton market, the exchange-traded cotton futures contract has been beneficial for all sections of the economy, including farmers and consumers. It provides advanced price signals to sellers (farmers/producers) and assists buyers (consumers) of agricultural commodities to decide on the time for purchase of the commodity, giving a tool for hedging the uncertainty in prices across time periods.

Keeping in view of the above discussion, the present study analyzed the price behavior of spot and futures markets for majorly traded cotton commodities in India, *viz*., cotton fibre and cotton seed oil cake. Futures contracts help in performing two important management functions, *i.e.*, price discovery and price risk management for the specific commodity. Since hedging and price discovery are the two most important functions of futures market, studies have attempted to examine the price discovery of futures markets by testing their long run co-movement and lead-lag relation. Given the above background, it should be pointed out that the above existing literatures pertaining to lead-lag relationship between price changes in international and domestic futures and spot markets are well established by information dissemination. Hence based on the research gap, the present study attempted to investigate which market price reacts first between spot and futures prices of selected agricultural commodities traded in National Commodity and Derivatives Exchange Limited (NCDEX) using appropriate econometric procedures with the specific objectives as follows: (i) To assess the performance of Indian spot and futures market for major cotton commodities of transaction; (ii) To determine the existence of long-run relationship between spot and futures market prices for cotton fibre and cotton seed oil cake; (iii) To capture the price deviations in the short run between spot and futures market prices and to estimate the degree of convergence towards the long run relationship; (iv) To understand the behavior and pattern of causality between spot and futures markets; and (v) To assess the efficiency of cotton futures market in its role of price discovery and risk management functions.

DATA AND METHODOLOGY

National Commodity and Derivatives Exchange Limited (NCDEX) being the largest agricultural commodity futures trading platform was selected among all the National Commodity Exchanges functioning in the country. The performances of cotton fibre and cotton seed oil cake commodities selected were studied because of their high value, trading volume and consistent performance on the NCDEX platform for a considerable period. The study was purely based on secondary data which was drawn from the official website (NCDEX, 2021). The data comprised of daily closing spot prices and futures prices with near month (expiration month) maturity pertaining to the sample agricultural commodity derivatives traded on the exchange. The near month futures contracts were selected for the analysis as they are considered as highly liquid and the most active contracts. The data on trading volume and open interest for the sample agricultural commodity derivatives were collected on a daily basis. The period of study was from 01 January 2010 to 31 December 2020 for cotton seed oilcake commodity and for cotton fibre the period was from 01 April 2013 to 31 December 2020. Assuming NCDEX is open only on trading days (not weekends or holidays), typical Indian exchanges have about 250 trading days per year, on average. The same has been considered in this study. Accordingly, the study employed 2750 and 1750 observations for cottonseed oilseed and fibre, respectively. The commodities and their respective data period as well as reference market for spot price is shown in Table 1.

Table 1: Data Period for the Sample Agricultural Commodity Derivatives

Sl. No.	Commodity	Specification	Data Period	Futures Market	Spot Market
1.	Cottonseed Oilcake	COCUDCKDI in Rs. per qtl	01 Jan. 2010 – 31 Dec. 2020	NCDEX	Kadi, Gujarat
2.	Cotton fibre	29mm lint in Rs. per bale	01 Jan. 2010 – 31 Dec. 2020	NCDEX	Rajkot, Gujarat

Tools of Analysis

Time series data pertaining to the sample agricultural commodity derivatives was analyzed using various statistical and econometric tools. Firstly, the base data of spot and futures prices was converted into continuous daily return series by taking natural logarithm. Natural logarithm of daily prices was taken to minimize the heteroscedasticity in data. Following Kumar and Pandey (2013) and several other studies, the rate of return for each day is defined as the difference between the natural log of a particular day's price and the natural log of the previous day's price as shown hereunder:

$$\mathbf{R_t = [\ln(\mathit{P_t}) - \ln(\mathit{P_{t-1}})],}$$

Where: R_t is the return for the day t, ln is the natural log, P_t and P_{t-1} are the closing prices for day 't' and its previous trading day. However, the base data of spot and futures prices was also used at appropriate stages of the analysis. In order to assess the effectiveness of futures market for cotton the present study proposed two sets of tools comprising ratio tests and cointegration and related techniques for examining the price discovery and market risk management. In the process, performance of cotton futures market was assessed on the basis of extent of liquidity, price volatility and basis risk. On the other hand, the efficiency of the commodity is examined on the basis of the econometrics techniques of cointegration, VECM, Granger causality, impulse response and variance decomposition. The data was analyzed using and STATA 18.0 software package.

(i) Descriptive statistics

The key statistics including mean, standard deviation, normality (using Jarque- Bera test), kurtosis and skewness were investigated for both spot and futures prices.

(ii) Ratio Tests

To assess the performance of pepper futures market, ratio the following ratio tests were employed:

a. **Extent of Liquidity = Total traded volume of cotton fibre or cotton seed oilcake / Total production of cotton fibre or cotton seed oilcake**
b. **Price Volatility = Standard deviation of futures prices of cotton fibre or cotton seed oilcake / Standard deviation of spot prices of cotton fibre or cotton seed oilcake**

(iii) Unit root test

In order to examine the cointegration of spot and futures prices for establishing long-term relationship, it is customary to first examine the level of integration in each of the given commodity price series. This can be done by examining the unit root properties in each commodity price series (Kumar, 2004 and Nath and Lingareddy, 2008). In this study, augmented Dickey-Fuller (ADF) test was employed to examine whether the sample commodity price series are stationary or otherwise. Further, the necessary lag length of the data series was selected on the basis of Schwarz Information Criterion (SC).

(iv) Johansen co-integration test

After testing the precondition of stationarity in the spot and futures market prices, Johansen and Juselius cointegration test was employed to determine the existence of a long-run relationship between the selected agricultural commodities traded in NCDEX. Johansen's Cointegration test is employed to examine long-run relationship among the variables after they are integrated in an identical order (Samal, 2017). The nature of long-run equilibrium relationship between the spot and futures market for the sample agricultural commodity derivatives is ascertained using Johansen's Cointegration test. In practice many financial variables contain unit root and are thus said to be integrated at first difference [I (1)]. The cointegration test is based on maximum likelihood estimation and uses two test statistics, namely trace statistics (λtrace) and maximum Eigen value statistics (λmax) to determine the number of cointegrating vectors.

(v) Lead-lag relationship

After identifying cointegration between spot and future prices of the selected agricultural commodities, the following regression model was employed to examine the lead-lag relationship between the two-price series:

$$\Delta SPOT_t = C_1 + \sum_{k=1}^{n} \alpha_{1i} \Delta SPOT_{t-k} + \sum_{k=1}^{n} \beta_{2i} \Delta FUT_{t-k} + u_{1t}$$

$$\Delta FUT = C_2 + \sum_{k=1}^{n} \beta_{1i} \Delta FUT_{t-k} + \sum_{k=1}^{n} \alpha_{2i} \Delta SPOT_{t-k} + u_{2t}$$

Where: $SPOT_t$ and FUT_t are spot and future market prices of individual agricultural prices at time t, u_{1t} and u_{2t} are white noise disturbance terms.

(vi) Vector Error Correction Model (VECM)

VECM model can only be used if variables have cointegration. Before evaluating efficiency and calculating VCEM, lag length selection is important. To capture the deviations in the short run within the framework of cointegration analysis, which implies stable long run co-movement, adjustment to temporary deviation was analyzed using VECM. The VECM allows for the short run shocks and estimates the degree of convergence towards the long run relationship. Before estimating the VECM, the numbers of lags of the spot and futures price series that are included in the VECM were identified on the basis of VECM lag order selection criteria. The equations for the test were specified as:

$$\Delta F_t = \alpha + \delta u_{t-1} + \sum_{i=1}^{k} \beta_i \Delta F_{t-i} + \sum_{j=1}^{k} \gamma_i \Delta S_{t-i} + V_t$$

$$\Delta S_t = \alpha' + \delta' u_{t-1} + \sum_{i=1}^{k} \beta'_i \Delta F_{t-i} + \sum_{j=1}^{k} \gamma'_i \Delta S_{t-i} + V'_t$$

Where: F and S refer to futures and spot prices, respectively of the selected commodities and V is white noise.

(vii) Granger Causality
Eagle Granger suggested that if cointegration exists between two variables in long run, then there must be either unidirectional or bidirectional Granger causality between these variables. The joint significance of all the lag of spot and futures prices included in the VECM was examined using Granger causality which measures precedence and information contents. Null hypothesis is no causality between futures and spot prices. The rejection of the null hypothesis implies information transmission from spot prices to future prices and vice versa. If the lags of both series are significant, there is a bi-directional flow of information. As given by Vimal (2015), the equations for the test were specified as:

$$F_t = a_0 + a_1F_{t-1} + ... + a_pF_{t-p} + b_1S_{t-1} + ... + b_pS_{t-p} + u_t$$

$$S_t = c_0 + c_1S_{t-1} + ... + c_pS_{t-p} + d_1F_{t-1} + ... + d_pF_{t-p} + v_t$$

Where: F and S refer to futures and spot prices, u, v are white noises.

(viii) Variance Decomposition
It indicates how much proportion of variation in spot prices is due to its own shock against the shock in futures prices and likewise for the variation in futures prices. The study reports the percentage variation in futures prices of cotton products explained by its own lagged values and by the lagged values of spot prices and similarly for spot prices. Percentage variation in cotton futures prices explained by its own lagged values and by the lagged values of spot prices and vice versa is captured over lagged time. Variance decomposition, gives information about the source of information in the forecast error.

RESULTS AND DISCUSSION
(i) Ratio Test
As mentioned above in the methodology section, that performance of cotton fibre and cottonseed oilcake futures market is assessed on the basis of extent of liquidity, price volatility and basis risk. It is seen from the Table 1 that the major portion of the total production of cotton fibre and cotton seed oilcake does not come to the futures market except for the year 2014-15, showing the less developed futures market. A producer doesn't find greater interest in futures trading because of less developed futures market. Low liquidity indicates that a producer doesn't find utility in futures exchange. The present findings refurbish that of Samal (2017) who attributed **limited participation** of the Indian farmers in general in the commodity markets, even for a commercial crop like cotton, due to several factors including: (i) **Low awareness and understanding** of futures contracts among farmers; (ii) **Inadequate institutional support** and poor access to market infrastructure; (iii) **Contract specifications** (like lot size) that are not aligned with small and medium-scale producers; and (iv) **Lack of trust and confidence** in the futures market system.

(a) Extent of liquidity

Table 1: Extent of liquidity of cotton-based commodity market

Year	Cotton Fibre Liquidity (%)	Cottonseed Oilcake Liquidity (%)
2013-14	0.17	0.32
2014-15	0.16	0.27
2015-16	0.33	0.29
2016-17	0.28	0.38
2017-18	0.31	0.56

(b) Price Volatility

Ratio of the standard deviation of the futures prices to spot prices of cotton-based commodities calculating price volatility ratio is reported in Table 2. The ratios are more than one most of the percentage times with 77.2 percentages in case of cotton fibre and 82.3 percentages in case of cottonseed oilcake indicating speculative activities in the futures markets. The percentage for ratio less than one is 7.5 times and 9.2 times, respectively, for cotton fibre and oilcake, showing that information is not fully incorporated. As the ratio equal to one is 6.7 times and 7.3 times for cotton fibre and oilcake, respectively, it shows that the percentage ratio of futures price is able to incorporate information efficiently and fully.

Table 2: Ratio of the S.D of the futures prices to spot prices of cotton based commodities

Year	Cotton Fibre			Cottonseed Oilcake		
	Price volatility ratio			Price volatility ratio		
	<1	=1	>1	<1	=1	>1
2013-14	0.0	0.0	100.0	0.0	0.0	100.0
2014-15	3.2	1.5	100.0	11.8	1.7	95.5
2015-16	0.0	11.8	95.5	4.4	8.5	88.9
2016-17	2.1	0.0	76.9	0.0	12.1	83.3
2017-18	9.8	0.0	78.5	7.5	0.0	66.7
Total	7.5	6.7	77.2	9.2	7.3	82.3

(ii) Efficiency tests
The efficiency of the spot and futures markets of cotton based commodities is examined on the basis of the econometrics techniques of co-integration, VECM, Granger causality and variance decomposition. The findings of each test are given hereunder.

(a) Unit Root Test
The results of unit root test can be seen in Table 3. Here, the null hypothesis is that both series have unit roots *i.e*., non-stationarity. At level prices, ADF (t -statistic) value is greater than critical value for both the series and probability value is also insignificant, indicating the presence of unit root at level. However, both the series become stationary at the first difference as critical value is greater than ADF (t -statistic). The results indicate that both series are not stationarity at levels, but their first differences are stationary (*i.e*., I (1) series). The same order of integration for both spot and futures prices reveal that there exists a long run price equilibrium relationship between these two prices. The trace test for cointegration of the two prices with the assumption of no trend in the data was carried out at lag interval of 5, which is selected on the basis of lag selection criterion.

Table 3: Unit root test for cotton fibre and cottonseed oilcake commodities

	Daily Spot and Futures Closing prices (At Level)			Daily Spot and Futures Closing prices (At First Difference)		
Prices	**ADF (t -Statistic)**	**5% Critical Values (t-Statistic)**	**Prob.**	**ADF (t-Statistic)**	**5% Critical Values (t-Statistic)**	**Prob.**
			Cotton Fibre			
Spot	0.92	-1.95	0.78	-12.41	-1.95	0.0000*
Future	0.89	-1.95	0.91	-10.18	-1.95	0.0000*
			Cottonseed Oilcake			
Spot	0.63	-1.95	0.67	-11.89	-1.95	0.0000*
Future	1.03	-1.95	0.91	-14.66	-1.95	0.0000*

Note: * indicates significance at 5% level of significance

(b) Cointegration Test
As shown under Table 4, the null hypothesis was tested on the number of cointegration equations. The result of trace test revealed that trace statistics value at 5 per cent level is greater than critical value, indicating rejection of null hypothesis *i.e.*, number of cointegration equations is none. The Maximum Eigen value test result for cointegration (Table 5) also confirms result shown by trace test. The result of trace test and Maximum Eigenvalue, rejects the null hypothesis of no cointegration in favour of the alternate hypothesis of one cointegrating equation. This has an important implication for the spot and future prices of cotton products as a stable long run relationship is established between spot and futures markets.

Table 4: Co-Integration on spot and futures prices of Cotton fibre & oilcake (Trace test)

Cointegration between	Hypothesized No. of Cointegrating Equations (CEs)	Eigen value	Trace Statistic	Critical Value @ 5 %	Probability
Daily spot closing and daily futures closing prices of cotton fibre	Ho: r = 0 (None)	0.312	43.78	15.18	0.000*
	H1: r <= 1 (At Most 1)	0.001	0.656	3.81	0.227

Daily spot closing and daily futures closing prices of cotton oilseed cake	Ho: r = 0 (None)	0.018	59.76	17.28	0.000*
	H1: r <= 1 (At Most 1)	0.000	1.95	4.08	0.512

Note: * indicates significance at 5% level of significance

Table 5: Co-Integration on spot and futures prices of Cotton fibre & oilcake (Max-Eigen Value Test)

Cointegration between	Hypothesized No. of Cointegrating Equations (CEs)	Eigen value	Trace Statistic	Critical Value @ 5 %	Probability
Daily spot closing and daily futures closing prices of cotton fibre	Ho: r = 0 (None)	0.096	32.97	15.49	0.000*
	H1: r <= 1 (At Most 1)	0.001	0.656	3.81	0.227
Daily spot closing and daily futures closing prices of cotton oilseed cake	Ho: r = 0 (None)	0.096	32.97	14.27	0.000*
	H1: r <= 1 (At Most 1)	0.000	1.95	4.08	0.512

Note: * indicates significance at 5% level of significance

In a similar study, Ali and Gupta (2011) analyzed the efficiency of futures markets for 12 agricultural commodities traded on the National Commodity & Derivatives Exchange Ltd (NCDEX) in India. Using Johansen's cointegration analysis the authors established significant cointegration between futures and spot prices for most commodities, indicating a long-term relationship.

(c) Lag Order Selection

Having examined the existence of a long run relationship between spot and futures prices above, the short run adjustment of such prices is being assessed through VECM. Lag with lowest value of LR, FPE, AIC, SC and HQ is selected for lag order selection criteria. Value of lag order selection criteria is lowest at lag 5 in four out of five tests for both cotton fibre and cottonseed oilcake commodities. According to VECM lag order selection criteria 5 lags of spot and futures prices are significantly different from zero as reported Table 6. With these lags, the post estimation diagnostics revealed no evidence of autocorrelation.

(d) Vector Error Correction Mechanism (VECM)

The results of the estimated VECM are presented in Table 6 and 7 for cotton fibre and cotton oilseed cake, respectively. It can be seen from the tables that the coefficient of at least one error correction term was significant for both cotton based commodities, confirming the presence of cointegaration. The coefficient of the error correction term in the case of spot price equation for both the commodities is found to be positive and significant. Thereby, spot prices are stable in the long run and any deviation in their prices due to external shocks that occurred in the short run is adjusted by the market forces over time.

Table 6: Error Correction Model for Futures and Spot Price of cotton fibre

Variables	ΔFuture		Δ Spot	
	Coefficient	Prob.	Coefficient	Prob.
Equilibrium error	-0.0075	0.35	0.0089	0.02*
Δ Future(-1)	0.0713	0.02*	0.3345	0.00*
Δ Future(-2)	-0.0317	0.42	0.0736	0.01*
Δ Future(-3)	-0.0981	0.01*	-0.0076	0.67
Δ Future(-4)	-0.0259	0.51	-0.0200	0.26
Δ Future(-5)	0.0392	0.29	0.0066	0.69
Δ spot(-1)	-0.0198	0.77	-0.1114	0.00*
Δ spot(-2)	0.0934	0.18	0.0050	0.87
Δ spot(-3)	0.1603	0.02*	0.1061	0.01*
Δ spot(-4)	0.1063	0.12	0.1084	0.00*
Δ spot(-5)	0.0375	0.49	0.0088	0.73

Note: * indicates significance at 5% level of significance.

Table 7: Error Correction Model for Futures and Spot Price of cottonseed oilcake

Variables	∆Future		∆ Spot	
	Coefficient	Prob.	Coefficient	Prob.
Equilibrium error	-0.1612	0.35	0.0072	0.00*
∆ Future(-1)	-0.0498	0.76	0.2298	0.11
∆ Future(-2)	0.1011	0.37	0.1635	0.02*
∆ Future(-3)	-0.0153	0.69	-0.10	036
∆ Future(-4)	-0.0172	0.22	-0.20	0.05
∆ Future(-5)	0.1192	0.25	-0.34	0.12
∆ spot(-1)	0.1637	0.43	-0.23	0.33
∆ spot(-2)	0.2156	0.22	0.25	0.31
∆ spot(-3)	0.0700	0.03*	0.12	0.01*
∆ spot(-4)	0.1168	0.15	0.23	0.00*
∆ spot(-5)	0.2834	0.61	0.0037	0.44

Note: * indicates significance at 5% level of significance.

The coefficient of error equilibrium was 0.0089 in spot market equation for cotton fibre and 0.0072 for cottonseed oilcake. This indicates that when average spot prices of both the commodities are too low and they immediately increase toward futures price by 0.89% and 0.72% respectively. As the value of coefficients is low in spot market at 0.89% for cotton fibre and 0.72% for cottonseed oilcake, the correction process is very slow. This gives an indication of slow informational efficiency of cotton-based commodities market. Therefore, the results broadly indicate that there exists long run relationship between futures and spot prices and the adjustment towards equilibrium is made by spot price. Further, the tables show that the short run coefficients depicted by ∆ futures (-i, where i indicates the lag period in months) which measure the return spillover from spot to futures market are significant at 5% level at lag 1 and 2. Such a result indicates that spot market is leading the futures market and there is unidirectional causality from spot to futures market in case of both cotton fibre and cottonseed oilcake.

(e) Granger Causality

The results of VECM on unidirectional causality from spot to futures price of cotton fibre and cottonseed oilcake market are further confirmed by Granger causality test. With the null hypothesis of spot price does not Granger cause futures price and futures price does not Granger cause spot price, the Granger causality results are furnished in Table 9. The F statistics test reject the null hypothesis of no Granger causality from spot to future prices, indicating that there is unidirectional causality from spot prices to futures. Future price is said to be granger caused by spot prices, means spot price helps in the prediction of futures price.

Table 8: Pairwise Granger Causality Tests for cotton-based commodities

Null Hypothesis:	Obs.	F-Statistic	Prob.
Cotton fibre			
Spot price does not Granger cause future price	1750	37.93	0.0258*
Future price does not Granger cause spot price		1.59	0.2299
Cottonseed oilcake			
Spot price does not Granger cause future price	2750	2.17	0.0175*
Future price does not Granger cause spot price		1.24	0.1066

Note: * indicates significance at 5% level of significance.

(f) Variance Decomposition

It indicates how much proportion of variation in spot prices is due to its own shock against the shock in futures prices and likewise for the variation in futures prices. The first panel of Table 9 and 10 report the percentage variation in cotton fibre and cottonseed oilcake futures prices explained by its own lagged values and by the lagged values of spot prices. As per the second panel of the tables spot prices variations explained by futures prices are much larger suggesting greater efficiency of futures market. This is in line with Arora and Chander (2023) who revealed that the forecast error variance of spot prices was significantly influenced by shocks in futures prices, whereas the forecast error variance of futures prices was predominantly explained by their own past values.

Table 9: Variance decomposition of cotton fibre spot and futures price Series

Period	Futures Prices Explained by	
	Spot Prices (%)	Futures Prices (%)
1	0.29	99.76
2	0.37	99.63
3	0.52	99.48
4	0.69	99.31
5	0.88	99.12
Period	**Spot Prices Explained by**	
	Spot Prices (%)	**Futures Prices (%)**
1	43.23	13.40
2	41.71	12.15
3	39.69	11.08
4	37.72	10.18
5	38.94	9.44

The results indicate that around 9.44% to 13.40% of the variations in spot prices of cotton fibre are explained by the futures prices, though in spot markets substantial variance is also explained by its own lagged value. On the other hand, spot returns appear to be explaining only 0.29% to 0.88% variation in the cotton fibre futures prices. On the other hand, the results of cottonseed oilcake indicate that around 16.77% to 47.71% of the variations in spot prices are explained by the futures prices, though in spot markets substantial variance is also explained by its own lagged value. On the other hand, spot prices appear to explain only 0.07 % to 0.44 % variation in the cottonseed oilcake futures prices. The findings are in line with Agrawal *et al*. (2023) who concluded that the cotton spot market dominates in price discovery, with the futures market playing a lesser role.

Table 10: Variance decomposition of cottonseed oil cake spot and futures price Series

Period	Futures Prices Explained by	
	Spot Prices (%)	Futures Prices (%)
1	0.00	86.60
2	0.07	87.85
3	0.13	88.92
4	0.25	89.82
5	0.44	90.56
Period	**Spot Prices Explained by**	
	Spot Prices (%)	**Futures Prices (%)**
1	73.43	16.77
2	76.47	28.29
3	78.94	39.42
4	80.96	40.31
5	85.17	47.71

CONCLUSION

This study investigated the relationship between spot and futures prices of cotton fibre and cottonseed oilcake in India using a battery of econometric tests. The co-integration model clearly indicated that the lag value of futures has little influence on spot markets of both cotton fibre and cotton oilseed cake. Further, the Granger causality test provided strong evidence that the futures market prices do not lead to spot prices. This is mainly due to the fact that the cotton fibre and cottonseed oilcake futures markets are constrained by exchange-specific problems such as low market depth and thin volume, irregular trading and lack of effective participation of the farmers. Thus, it can be concluded that the futures market for cotton and cotton oilseed cake in India is inefficient. Therefore, to enhance the market's efficiency and usefulness for risk management, policy initiatives must focus on improving market infrastructure, awareness, and participation, especially at the grassroots level.

Policy Recommendations

The efficiency of cotton-based futures markets can be improved by increasing the participation of farmers in the futures market, developing futures market in the locality of spot markets, improving grading and standardization system and by managing the exchange-specific problems. All these issues can be tacked with the help of a four-pronged strategy, *viz.*, (i) creating large scale awareness among farmers by focusing on market-oriented extension services; (ii) mobilizing farmers under groups to pool their resources; (iii) decreasing the current lot size of cotton-based futures contracts; and (iv) incentivizing and integrating e-NAM with futures trading components.

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