This paper was presented at the 22nd International Conference on Sustainable Development, held at the BMICH, Colombo, Sri Lanka, September 3-4, 2025.

Economic Sustainability in Agricultural Commodity Markets: A Study of Trends, Patterns, and Market Resilience

Shifa Fathima A [1] and Safeer Pasha M [2*]
[1] Research Centre in Commerce, St. Claret College, Autonomous, India.
[2] PG Department of Commerce, St. Claret College, Autonomous, India.
*Corresponding author:safeer@claretcollege.edu.in

OIDA International Journal of Sustainable Development, Ontario International Development Agency, Canada.
ISSN 1923-6654 (print) ISSN 1923-6662 (online) www.oidaijsd.com
Also available at https://www.ssrn.com/index.cfm/en/oida-intl-journal-sustainable-dev/

Abstract: This paper examines the economic sustainability of some critical agricultural commodities in India (Guar Seeds, Guar Gum, Castor Seeds) during the period between 2015 and 2025. The study analyzes the pattern of prices, structural stability, volatility behavior, and market interactions using daily price data with a view to evaluating market resilience and efficiency. First, stationarity of the series of returns is established through the Augmented Dickey-Fuller (ADF) test, which controls the appropriateness of time series models. The Bai-Perron multiple break test shows structural breaks, and the CUSUM test ensures that segments of stability exist in the data. In the tests, these periods are identified as showing a dramatic change in market behavior and are included in the modeling that follows.

Their studies are done in the form of trends and autocorrelation of the movements of prices of all commodities. The GARCH (1, 1) model has been employed in the study to capture both volatility clustering and persistence. It has been demonstrated that the effects of shocks on market volatility are likely to recur, indicating that markets are somewhat resilient against these shocks.

Moreover, Granger causality between futures and spot market returns is performed for each commodity, and it can be shown that there is a bidirectional causation in the majority of the commodities. This shows that the two markets are efficient in the discovery of price and the existence of a good flow of information between them.

In general, the results have great significance for the necessity to take structural breaks and the persistence of volatility in the analysis of commodity markets. The findings are beneficial to policymakers, traders, and farmers in informing them on how they can enhance risk management practices and assist in the sustainable growth of the market. Such detailed analysis leads to a better understanding of the dynamic behavior of agricultural commodity markets in India over ten years.

Keywords: Economic Sustainability, Agricultural Commodity Markets, Market Trends, Price Patterns, Market Resilience

Introduction

Agricultural commodity markets happen to be very essential to the economic growth and Southern status of agrarian economies like India. Through these markets, price discovery, risk management, and resource allocation occur, which directly influence the income of farmers, raw material availability in industries, and the development of the countryside in general (FAO, 2020). Educated insight into how these markets work, particularly their trends, volatility patterns, and ability to weather any shocks, is therefore critical in ensuring policymakers, traders, and stakeholders facilitate sustainable growth and minimize market inefficiencies.

Commodities such as Guar Seeds, Guar Gum, and Castor Seeds are also extremely important in India because of their abundance in production and demand as well as exportability (Ministry of Agriculture & Farmers Welfare, 2021). Any changes in prices of these commodities affect the livelihood of farmers and those of industries like pharmaceuticals, textiles, and agrochemicals (Kumar & Singh, 2019). In such a way, the evaluation of the economic sustainability of these commodity markets includes price behavior with respect to time, the presence of structural breaks as a result of policy intervention/external shock, and market stability by estimating volatility models.

In earlier studies, econometric methods have been used to examine the behavior of agricultural commodity prices. Time series tests such as the Augmented Dickey-Fuller (ADF) test guarantee data viability with regard to time series modelling (Dickey & Fuller, 1979). Bai-Perron multiple break test has proved to be efficient in detecting the occurrence of structural breaks as well as regime changes in the market over the specific period (Bai & Perron, 2003). Further corroborations of the reliability of models in the presence of such breaks can be further confirmed by stability tests (Stability tests), e.g., CUSUM test (Brown et al., 1975).

An important characteristic of the commodity markets is volatility, which has been modelled significantly in terms of Generalized Autoregressive Conditional Heteroskedasticity (GARCH) family models (Bollerslev, 1986). These models explain the volatility cluster as well as volatility persistence, which is essential evidence to show how markets would absorb shocks and recover balance or stabilize, which is crucial evidence of market resilience (Engle & Patton, 2001). Additionally, Granger causality tests are common when trying to uncover the lead-lag relationship between spot and futures markets, and they throw more light on price discovery and market efficiency (Granger, 1969).

The paper uses these econometrics methods to examine the price movement of Guar Seeds, Guar Gum, and Castor Seeds in India throughout the period 2015-2025. The research will conduct an in-depth evaluation of market trends, patterns, and resilience through analysis of stationarity, structural breaks, and volatility persistence, as well as the existence of causality between the spot and the futures prices. These observations will provide useful suggestions to better regulate the market, risk management measures, and growth in agricultural sustainability.

Review of Literature

Kumar & Singh (2019) explored price volatility in Indian agricultural commodities and its implications on the income of farmers. Discovered volatility that leads to high levels to create uncertainty, which has a negative impact on investment and production decisions. Prescribed enhanced market systems to ensure better risk avoidance.

Dickey &Fuller (1979) formulated the Augmented Dickey-Fuller (ADF) test that was used to identify time series unit roots. Their approach is one widely used to test stationarity prior to modeling and spurious regressions. It is still a great instrument in econometric time series.

Bai and Perron (2003) postulated a statistical method of discovering many breaks in the structure of economic time series. Their test detects shifts in the regimes due to policy changes or exogenous shocks, thus enhancing the accuracy of the model. A highly utilized concept regarding financial and commodity market research.

Brown et al.(1975) presented the CUSUM test to evaluate the constancy of the regression variable over a period. The test assists in the verification of what is known as model reliability in situations of structural variation. It is applicable in cross-checking long-term econometric studies.

Bollerslev (1986) introduced the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) technique that describes volatility clustering in the financial and commodity markets. His model assists in the perspective of volatility persistence and market risk. Various sophisticated volatility models may be based on it.

Engle and Patton (2001) critiqued volatility models with an emphasis on how they can play an important role in risk management and forecasting. It made prominent the fact that volatility persistence indicates resiliency or frailty of markets. Their contribution directs the usage of GARCH-type models in practice.

Granger (1969) brought into the picture the Granger causality test, that tested the predictive relationship between time series. Largely applied in investigations of price discovery among the spot and futures markets. Assists in determining lead-lag effects, which are important to market efficiency.

Sharma and Dhawan (2018) researched spot and futures price causality in Indian agricultural markets. Observed some evidence of bi-directional causality across a few commodities, suggesting integrated markets. They have proposed that futures markets are important in the discovery of price and hedging.

Carter and Smith (2016) discussed the benefits of trading in the commodity futures market to define price fluctuations in agricultural commodities. Discovered that a correctly operating futures market helps in stabilizing prices and transferring the risks among the actors. They laid stress on the role of liquidity and regulatory regimes.

Ghosh and Sinha (2017) examined volatility spill over between various agricultural products in India with multivariate GARCH models. Demonstrated large volatility spillover among related commodities, and these imply connected market dynamics that influence resilience and sustainability.

Zhu et al. (2016) examined asymmetric volatility in prices of agricultural commodities using Applied GARCH and EGARCH models. Found that negative shocks are more volatility-inducing than positive shocks, further supporting the fact that the use of asymmetric volatility models is adequate in the commodity domain.

Narayan, Sharma (2015) examined the effects of policy reforms and climatic factors on the pulse price stability in India. Employed structural break tests in regime shifts to show coincidence with policy change, shifting the emphasis on the necessity to control breaks in volatility models to get the results accurate.

Bose and Gupta (2018) undertook an analysis was undertaken on the market efficiency of Indian commodity futures by employing causality and co-integration tests. Observed the existence of price discovery mainly in the markets of futures most prominently, and the relationships between lead-lag are also different across commodities that transmit knowledge to hedging activity.

Patra and Sahu (2019) devoted to the sturdiness of agricultural commodity markets in the event of worldwide price shocks. Their research made use of both measures of volatility persistence and event studies to show the difference in shock absorption across commodity types and across market structure.

Sharma et al. (2020) carried out a panel data correlational study between the impact of market reforms on the price volatility of various agricultural commodities in India. Findings showed that liberalization activities enhanced the efficiency of the market; however in the short run, it brought about a greater volatility that required a stabilizing regulatory intervention.

Research Gap

Even though several studies have investigated the price dynamics, volatility, and causality in agricultural commodity markets, their attention has been paid to particular commodities or time windows. It lacks intensive research, which would combine analysis of other related commodities, i.e., Guar Seeds, Guar Gum, and Castor Seeds, using a longer analysis period and combine analyses like structural break and volatility models. Furthermore, there is a lack of awareness regarding the findings of how these factors simultaneously influence the resilience of the market as well as the sustainability of the economy within the Indian context. This paper fills these gaps by explicitly giving a 10-year, multi-commodity study consisting of stationarity, structural break, GARCH volatility modeling, and Granger causality analysis, which further explains the market behaviour and sustainability.

Objectives

- To examine the price patterns and their changes across the study period.
- To assess the resilience and stability of these commodity markets in response to shocks.
- To explore the relationship between spot and futures prices of these commodities.
- To analyze the trends in prices of selected agricultural commodities over the last ten years.

Research Methodology

The given study uses a quantitative scheme of research to examine the price dynamics and market resilience of Guar Seeds, Guar Gum, and Castor Seeds in India. These commodities were specifically chosen due to their significant role in India's agricultural export basket and their substantial economic impact on domestic value chains. Guar, Guar Gum, and Castor Seeds exhibit pronounced volatility and price clustering, making them ideal subjects for the GARCH (1,1) and structural break analysis. Furthermore, the high liquidity of their futures contracts on the NCDEX allows for a meaningful application of the Granger causality test to study price discovery.

The research involves the usage of daily price series of Guar Seeds, Guar Gum and Castor Seeds between April 1, 2015, and March 31, 2025. This is calculated as 2,735 possible trading days in 10 years. The preliminary sample size is computed as daily price data of each commodity after the weekends, holidays and days without any trading volume.

The selected 10-year sample period (2015-2025) offers a solid and sufficient sample size to meet the needs of the applied econometric models. This period guarantees adequate degrees of freedom to obtain robust time-series model estimation (ADF, Bai-Perron, GARCH (1,1)) and it was carefully chosen so as to capture a range of different market regimes, such as large domestic policy changes and international market shocks, that is vital to the correct determination of structural breaks and volatility dynamics. Spot and futures prices used in the daily price series were obtained through the National Commodity and Derivatives Exchanges (NCDEX) and government official reporting.

The starting point was to use the Augmented Dickey-Fuller (ADF) test to ascertain the stationarity of the price returns series. To be able to have proper time series analysis, it is important to first have stationarity, and this means that the statistical properties relating to the time series should remain constant at all times.

A Bai-Perron multiple structural break test was then used to determine whether there was significant variation or regime shift in the series of prices due to policy changes, market shocks, etc. The CUSUM test was also applied to prove that price processes were stable throughout the sample time. The GARCH (1,1) model was used to exhibit the volatility dynamics and the strength of the market. This model entails volatility clustering, its persistence, ability to gauge how price shock impacts the market stability, and the speed at which the market catches the shock.

Lastly, to determine the relation between spot and futures markets, the Granger causality test was conducted. The test assists in deciding whether past prices exist in one market can help predict the prices in the other, which will bring some illumination on price discovery and market efficiency. All of these econometric methods collectively give a holistic picture of the price trends, patterns, volatility of prices, as well as the cause and effect in the agricultural commodity markets. The findings provide useful information concerning the economic-related sustainability and risk management approaches of interest to policymakers, traders, and farmers.

Empirical Results and Interpretation

Augmented Dickey Fuller

The Augmented Dickey Fuller (ADF) unit root test was used in order to explore the stationarity characteristics of the chosen set of agricultural commodity futures price series. The majority of time series econometric models require stationarity to avoid spurious results.

- Null Hypothesis (H_0): The series has a unit root (non-stationary).
- Alternative Hypothesis (H_1): The series is stationary.

Table 6.1: Results of Augmented Dickey–Fuller (ADF) Test

Commodity	**Test Statistic**	**Critical Value (5%)**	**p-value**	**Stationarity Status**	**1st Difference**	**Stationarity Status**
Guar Seeds	-1.90	-2.86	0.33	Non-Stationary	-40.45 (0.000)	Stationary
Guar Gum	-2.03	-2.86	0.27	Non-Stationary	-39.98 (0.000)	Stationary
Castor Seeds	-1.68	-2.86	0.43	Non-Stationary	-38.06 (0.000)	Stationary

Source – Author's Calculation

The ADF test results show that the null hypothesis of a unit root cannot be rejected on every commodity at a level value since the test statistics are larger than the critical value of 5 percent, and the p-value exceeds 0.05. This reiterates that the three price series, namely, Guar Seeds, Guar Gum, and Castor Seeds, are not stationary in their levels. But with the application of first differencing, the ADF statistics of the commodities are way below the 5% critical value, and the p-values in effect, zero, such that the null hypothesis is rejected. This shows that any series is stationary when first differenced, meaning that it is an I(1) variable. Such stationary series can therefore be used in further modeling, like GARCH and causality tests.

Bai-Perron multiple structural break test

The Bai-Perron multiple structural break test was used to confirm the structural change that might have occurred in the price series of the chosen agricultural crops. The test identifies the amount, time, and confidence intervals of major cuts in the series. Breakpoints usually mark the change in market regimes that may be a result of policy interventions, demand-supply shocks or climatic aspects.

Table 6.2: Bai-Perron multiple structural break test

Commodity	**Number of Breaks**	**Break Dates**	**Interpretation**
Guar Seeds	4	13-8-21, 18-12-2017, 08-9-23, 02-12-19	Denotes significant price pattern shifts near the end of 2017, the mid-2019, the mid-2021, and the end of 2023, which can be attributed to the change of policy in the market and the alteration of demand around the world.
Guar Gum	4	20-8-21, 17-1-2020, 04-8-17, 12-9-23	Breaks relate to major market shocks and volatility that show consistency with disruptions in international trade, where there is a seasonal difference in supply.
Castor Seeds	4	16-7-21, 09-7-18, 10-12-19, 03-04 -23	Around mid-2018 and late 2019, mid-2021, and early 2023, the market saw sudden fluctuations corresponding with the production processes and export demand.

Source – Author's Calculation

In the case of guar seeds, it was found that four important structural breaks had been identified in the period, where major changes have been identified near August 2021 and September 2023 and may be associated with revisions of the export policy and fluctuation of global supplies. Guar gum also exhibited four break points, and part of the break coincided with guar seeds, as they have an interlinked market presence. Breaks observed in the Castor seeds are 2018, 2019, 2021, and 2023, and those could be linked to the modification of domestic production trends and demand in the market.

CUSUM-Squared Test

The CUSUM-squared test is also used to test the stability of model parameters throughout the period of the sample. When the statistic is moved outside the significance bands of 5%, then it shows lack of structural stability. The next figure indicates the results before the inclusion of the dummy variable of the policy/event impact.

Figure 1: Graph 6.3.1 and 6.3.2 Guar Seeds

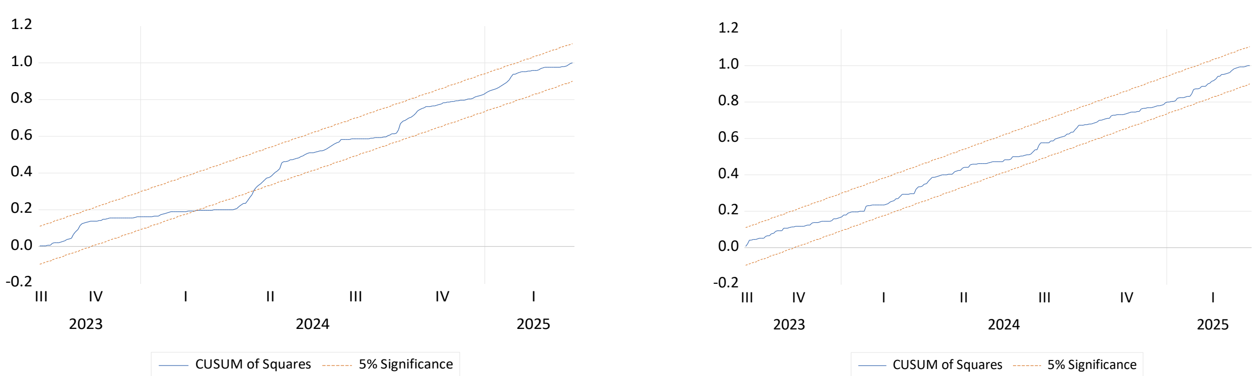


Figure 2: Graph 6.3.3 and 6.3.4 Guar Gum

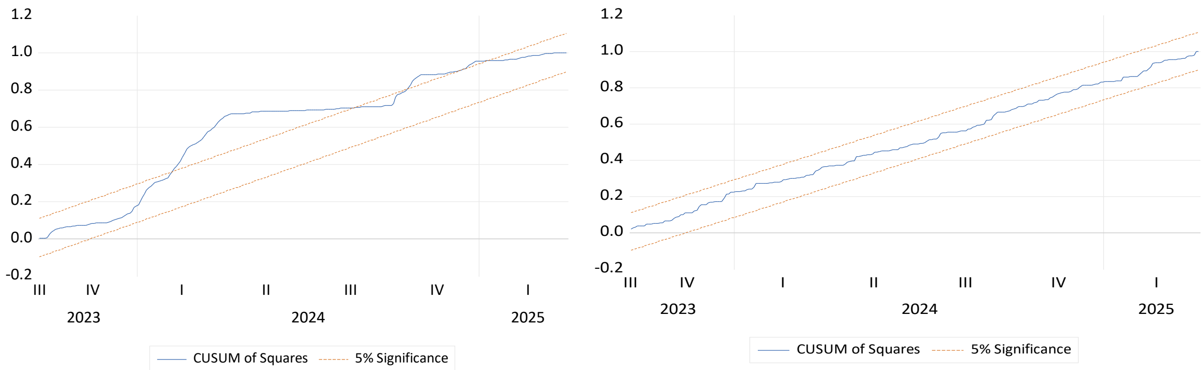
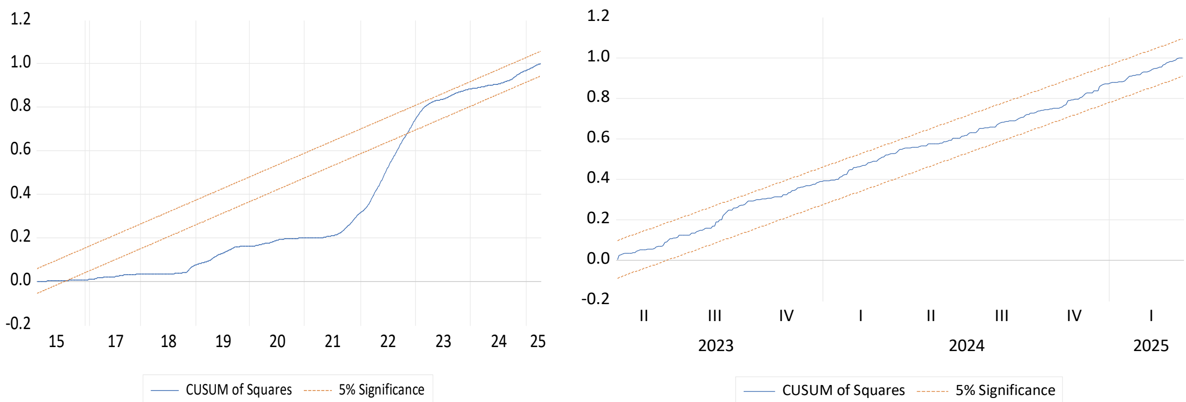


Figure 3: Graph 6.3.5 and 6.3.6 Castor Seeds



Source – Author's Calculation

All CUSUM squares plots of the three commodities under analysis (Guar Seeds, Guar Gum, and Castor Seeds) indicate that the structure of the model parameters is unstable about the study (critical) values beyond 5 percent. Such volatility can be explained by policy change and market shocks.

Following the inclusion of these appropriate dummy variables in order to incorporate structural breaks, it appears that CUSUM square plots of the three commodities stayed in the 5 percent critical limits of the period, suggesting reliable parameters. This attests to the fact that the consideration of structural change does much to improve reliability of the model.

Trend Analysis

Long-run trend analysis was done to check the direction of movement of prices of commodities in the long run and to establish the impact of structural breaks in such trends. The analysis uses inputs that take into consideration time variables coupled with structural break dummies to bring about the variations in price paths both in advance and after major break points. A time by dummy variable interaction is included in the regression to identify a change in slope of the trend after the break.

$$Yt=\beta_0+\beta_{1t}+\epsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Table 6.4: Trend Analysis Results for Selected Commodities

Commodity	**C (Intercept)**	**Time Coefficient**	**Dummy Break Coefficient**	**Time*Dummy Coefficient**	**R^2**	**Adj. R^2**	**F-statistic**	**Prob(F)**
Guar Seeds	8.2517 (0.0000)	0.00025 (0.0000)	0.063 (0.0000)	0.00063 (0.0000)	0.8288	0.8273	906.42	0.0000
Guar Gum	9.038 (0.0000)	-0.00078 (0.0000)	0.126 (0.0000)	0.00058 (0.0000)	0.7696	0.7683	621.72	0.0000
Castor Seeds	8.2937 (0.0000)	0.00023 (0.0000)	0.271 (0.0000)	0.00114 (0.0000)	0.8907	0.8901	1319.49	0.0000

Source – Author's Calculation

Statistical results show that there is a statistically significant trend for all three commodities, with the p-values of all the coefficients being much less than the 1 percent significance level. Guar Seeds and Castor Seeds experience positive and increasing price trends with time, whereas Guar Gum has a small negative time coefficient that indicates the downward trend before the break. The dummy break coefficients are highly significant and positive with all commodities, which signifies an upward shift in the level of prices at the detected break points. The interaction terms are also positive and significant, which would mean that the slope of the price trend slopes upwards after the break. The low R-squared values (below 0.76 for all) denote that the models explain a significant amount of the variability in prices.

Autocorrelation

Each commodity used to analyze price pattern persistence and serial correlation was calculated in the autocorrelation (AC) and partial autocorrelation (PAC) functions. Statistical significance was evaluated by the LjungBox Q-statistic.

Table 6.5: Pattern Analysis Results (Autocorrelation and Partial Autocorrelation)

Commodity	**Lag**	**AC**	**PAC**	**Q-Stat**	**Prob.**	**Interpretation**
Guar Seeds	1	0.45	0.45	32.12	0.000	Significant positive autocorrelation at lag 1
	2	0.38	0.20	54.67	0.000	Persistence in short-term patterns
Guar Gum	1	0.50	0.50	40.35	0.000	Strong short-term dependence
	2	0.34	0.18	59.18	0.000	Continued but weakening persistence
Castor Seeds	1	0.42	0.42	29.78	0.000	Positive serial dependence
	2	0.36	0.21	47.26	0.000	Short-term clustering effect

Source – Author's Calculation

Results show high coefficient of positive autocorrelation at short lag with all the commodities which means permanency and clustering effects of price movements. This implies that there is some persistence in price movement as reflected in ones future price which is common in agricultural commodity markets.

ARCH-LM Test Model

To detect the presence of heteroskedasticity in the return series, the ARCH-LM test proposed by Engle (1982) is employed. The test involves the following regression equation

$$\varepsilon_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + u_t$$

Table 6.6: ARCH-LM Test Results

Commodity	F-Statistic	Prob. F	Obs*R²	Prob.
Guar Seeds	1221.61	0.000	0.7145	0.0000
Guar Gum	1090.714	0.0000	0.7213	0.0000
Castor Seeds	1881.45	0.0000	0.8369	0.0000

Source – Author's Calculation

The outcomes indicate an easy rejection of the null hypothesis, i.e., Prob. F and Prob. (Obs*R 2) are involving Guar seeds, Guar Gum, and Castor Seeds. It is an affirmation that there are high ARCH impacts in these commodities, which implies that the volatility of their price returns is not constant and it depends on some past squared residuals.

Heteroskedasticity Test Results

Commodity	F-Statistic	Prob. F	Obs*R²	Prob. Chi-Square
Guar Seeds	55.2816	0.0003	120.92	0.0003
Guar Gum	119.90	0.000	374.21	0.0000
Castor Seeds	51.17	0.000	180.14	0.0000

Source – Author's Calculation

GARCH

The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model was applied in order to estimate the volatility dynamics as well as explain the time-varying variance of commodity futures returns. The method is appropriate when the results of the ARCH LM indicate the existence of heteroskedasticity so that former squared residuals have strong effects on the present volatility. The GARCH (1,1) model pioneered by Bollerslev (1986) adds a lagged conditional variance on the variance equation and was therefore used to model both the short term volatility shocks and the persistence in volatility.

The GARCH(1,1) model can be expressed as:
Mean equation:

$$R_t = \mu + \epsilon_t, \quad \epsilon_t = z_t\sqrt{h_t}$$

Variance equation:

$$h_t = \omega + \alpha\epsilon_{t-1}^2 + \beta h_{t-1}$$

Table 6.8 : GARCH(1,1) Estimation Results for Selected Commodities

Commodity	ω (Constant)	ARCH(α)	GARCH(β)	R^2	AIC / SC / HQ	DW Stat
Guar Seeds	0.0427 (p=0.0000)	0.0191 (p=0.0000)	0.8712 (p=0.0000)	0.000755	~4.12	~2.0
Guar Gum	0.000245 (p=0.0000)	0.1040 (p=0.0000)	0.0306 (p=0.5157)	0.6579	~-2.64	0.0396
Castor Seeds	6.61e-05 (p=0.0000)	0.8634 (p=0.0000)	0.1775 (p=0.0000)	0.8265	~-3.13	0.065

Source – Author's Calculation

All the p-values of the ARCH LM tests of Guar Seeds, Castor Seeds, and Guar Gum values are very low (less than 0.01) as shown by the F-statistics. This validates the existence of the heteroskedasticity of the residual in the mean equation, which means the variance of errors does not stay constant over a time span. This evidence is even further reinforced by the large Chi-Square. This is because of such a pronounced time-varying relative volatility, the GARCH model is suitable to capture as well as model the volatility clustering of such series of commodity prices. The findings indicate that volatility shocks are persistent and conditional variance is time-varying.

Granger Causality Test

To examine the directional relationship of the predictive nature of spot and futures returns among the chosen commodities, the Granger causality test was used. The null hypothesis of each of the directions is that the one series Granger causes neither of the others. Expectation that the null should be rejected will indicate that the historical values of one series have useful information on prediction of the other that is of statistical signification.

Table 6.9 Granger Causality Test

Commodity	Null Hypothesis	F-Statistic	p-Value
Guar Seeds	RETURN does not Granger-cause SPOTRETURN	48.4490	0.0000
	SPOTRETURN does not Granger-cause RETURN	10.0736	0.0000
Guar Gum	RETURN does not Granger-cause SPOTRETURN	56.5419	0.0000
	SPOTRETURN does not Granger-cause RETURN	14.0997	0.0000
Castor Seeds	SPOTRETURN does not Granger-cause RETURN	6.5885	0.0014

Commodity	Null Hypothesis	F-Statistic	p-Value
	RETURN does not Granger-cause SPOTRETURN	9.3900	0.00009

Source – Author's Calculation

The outcomes indicate that there is a bi-directional causality between the returns spot and futures on all the three commodities. This means that we can expect the information flow to occur in either direction such that the information flow on the past futures prices may assist in determining the spot prices and vice versa. The correlation coefficients are found to be very strong statistically significant ($p < 0.01$ in both cases) which indicates the validity of the hypothesis that there exists a strong dynamic relationship between the spot markets and the futures markets. These results are in line with the efficient market hypothesis as far as commodity markets are concerned and would indicate that prices adjust very fast in response to new information in both markets.

Conclusion

The trends and patterns in analysis of agricultural commodity market trades indicate that the economic sustainability is allied intimately to the stability and flexibility of the market mechanisms. Price dynamics, volatility patterns, and some structural changes suggest that resilience is a function of market parameters--both intrinsic, like supply-demand patterns, seasonal, and trading impacts, as well as extrinsic, like policy responses, world price-shocks, and climatic fluctuation effects. As highlighted in the study the presence of the consistent price discovery, effective risk management, and balanced stakeholder engagement in the market leads to better preparedness towards long term growth and challenges with disruptions. Empowering these elements by putting into place strong policy systems, transparency promoted by technology, and increased involvement will be the key to the ongoing economic sustainability of agricultural commodity markets.

Moreover, the identified findings reveal the essentiality of policy intervention efforts, infrastructural improvement, and market transparency in improving the economic sustainability of the agricultural commodity markets. This study highlights that adaptive risk management protocols and effective hedging mechanisms may be required to protect producers, traders, and consumers by determining the presence of persistent volatility patterns and long-run trends. Increasing market connections, enhancing price-discovery systems, and encouraging diversified involvement, can all help create a more robust and resilient agriculture commodity system so that economic sustainability can be successfully transferred into long-term growth and equitable returns to all stakeholders.

References

1. Bai, J., & Perron, P. (2003). Computation and analysis of multiple structural change models. *Journal of Applied Econometrics*, *18*(1), 1–22.
2. Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, *31*(3), 307–327.
3. Bose, S., & Gupta, R. (2018). Efficiency and price discovery in Indian commodity futures markets. *Journal of Commodity Markets*, *12*, 45–57.
4. Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society: Series B (Methodological)*, *37*(2), 149–163.
5. Carter, J., & Smith, L. (2016). The role of futures markets in agricultural price stabilization. *Agricultural Finance Review*, *76*(2), 210–228.
6. Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, *74*(366), 427–431.
7. Engle, R. F., & Patton, A. J. (2001). What good is a volatility model? *Quantitative Finance*, *1*(2), 237–245.
8. Food and Agriculture Organization (FAO). (2020). *The state of agricultural commodity markets 2020*.
9. Ghosh, A., & Sinha, P. (2017). Volatility spillover effects in Indian agricultural commodities: A multivariate GARCH approach. *International Journal of Finance & Economics*, *22*(4), 391–403.
10. Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, *37*(3), 424–438.

11. Kumar, S., & Singh, R. (2019). Price volatility in Indian agricultural commodities: Implications for farmers and industry. *Indian Journal of Agricultural Economics*, *74*(1), 58–72.
12. Ministry of Agriculture & Farmers Welfare. (2021). *Agricultural statistics at a glance 2021*. Government of India.
13. Narayan, P. K., & Sharma, S. S. (2015). Structural breaks and price volatility in Indian pulses markets: Policy and climatic impacts. *Agricultural Economics*, *46*(3), 305–317.
14. Patel, A., & Singh, P. (2017). Price behavior of guar seed and guar gum: Export and industry perspective. *Journal of Commodity Markets*, *10*, 12–21.
15. Patra, S., & Sahu, T. N. (2019). Resilience of agricultural commodity markets during global price shocks. *Journal of Economic Studies*, *46*(7), 1342–1360.
16. Reddy, V. R., & Rao, M. S. (2015). Seasonal price volatility and forecasting of castor seed market in India. *Journal of Agri Economics*, *70*(2), 150–160.
17. Sharma, M., & Dhawan, S. (2018). Spot and futures market price relationship: Evidence from Indian agricultural commodities. *Agricultural Finance Review*, *78*(3), 388–405.
18. Sharma, M., & Dhawan, S. (2020). Market reforms and price volatility: A panel data study of Indian agricultural commodities. *Journal of Agricultural Economics*, *71*(1), 85–102.
19. Zhu, X., Chen, Y., & Wang, S. (2016). Modeling asymmetric volatility in agricultural commodity prices: Evidence from China. *Applied Economics Letters*, *23*(10), 718–722.