Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/16614
DOI URL: http://dx.doi.org/10.21474/IJAR01/16614

ISSN NO. 2320-5407

RESEARCH ARTICLE

AN EMPIRICAL ANALYSIS OF PRICEDISCOVERY EFFICIENCY OF THE MAIZE FUTURESMARKET IN INDIA

Gouri Prava Samal
Rama Devi Women's University, Bhubaneswar - 751022, Odisha.

Manuscript Info

Manuscript History
Received: 05 February 2023
Final Accepted: 09 March 2023
Published: April 2023

Key words:-
Maizefutures, Spotprice, Efficiency, NCDEX, India

Abstract

Purpose - The present study examines the efficacy of the maize futures market of India in forecasting future spot pricesfor April 2020-March 2022.
Design/methodology/approach - In this study, Granger causality tests and the Vector Auto Regression (VAR) model are used. The initial application of the Augmented Dickey-Fuller (ADF) test was to observe the stationarity in the spot and futures price series.
Findings - The findings specified that allthe variables are stationary at the point of the first difference.According to the VAR model, neither the lag value of futures nor the same spot price of maize has a substantial impact on each other. Furthermore, the Granger Causality test suggested that the futures market has an insignificant ability to predict subsequent spot prices of maize in India.
Originality/value - The results of this study will be beneficial for different players namely hedgers, speculators, commodity exchanges, policymakers, researchers, etc. who have a noteworthy interest in the agricultural commoditymarkets.

Introduction:-

Trading in agricultural commodities is not a recent development. It would not be incorrect to say that commodity trade predates human civilization because it is most likely one of the oldest economic activities. From the barter system through spot markets to futures markets, commodities trading has seen enormous transformation throughout the ages. Markets for agricultural futures serve largely as a means of determining prices and controlling market risks related to volatility in prices and stock holding. The risk of carrying a commodity gradually must be compensated for by a future spot price that is greater in comparison to the current futures price. Farmers will typically hang onto stocks provided futures prices are lesser in comparison to predicted future spot prices net of storage costs, according to market participants. Spot and futures prices must move in tandem through time for markets to be efficient and prevent arbitrage opportunities. The main objective of the futures market is price discovery and risk management.Therefore, to effectively execute the roles of risk management and price discovery,it is expected thatthefuturesmarketsshouldmeettheelementaryhypothesisofmarketefficacy, i.e. futures price should be a fairforecasterofthe spotprice. The volume of contracts transacted on Indian futures markets has significantly improved since 2003 when national commodities exchanges in India first opened for trading. However, since the advent of futures markets, prices have become extremely volatile and unpredictable. Thus, to recommend strategies for boosting these markets, it’s crucial to empirically study the price as well as trade behavior of agri-commodities. The current study focuses on maize in particular because, after rice and wheat, it is India's third most important grain crop.Also,

Corresponding Author:- Gouri Prava Samal
Address**:-** Rama Devi Women's University, Bhubaneswar - 751022, Odisha.

approximately 10% of the nation's overall production of food grains is accounted for by it. Moreover, maize is known as the Queen of Cereals due to its diverse uses.Though maize has huge importance in the Indian economy, the efficacy of the maize futures market in India is yet to be assessed.Hence, the efficiency of price discovery on the Indian maize futures market was examined in the current paper.

Literature Review:-

On the effectiveness of price discovery in the commodities futures market, numerous research has been done.According to the study, a futures contract's success is negatively impacted by the size of the underlying spot market, suggesting that higher output does not increase hedging(Neharika, 2020)**.** The movement in spot prices can be used as a price discovery tool for futures market trades (Sumathy, Shankar, Sumathy, & Charles, 2016)**.** Multiple breakdowns in the co-integrating relationship between spot and futures prices were found as a result of empirical evaluations, and sub-periods were subsequently discovered in the cause-and-effect relationship between futures and spot prices (Massimo, Lucia, & Daniela, 2013). Contrary to this, another study indicated that there was a high co-integration among spot returns, volume, and open interest of all the commodities, forming a strong relationship between the series (Inderpal, 2015). Similarly, another study concludes that there is bidirectional long causation running between futures and spots (Prakash & C, 2021). The analysis also showed that there was a unidirectional causal relationship and that volatility was spreading from the stock market to the commodities market (Salim, 2021). There existed a bi-directional spill-over effect in the case of most of the commodities whereas spill-overs from futures returns to spot returns were more notable(Ruchika, Nawal, & Namita, 2018). Price discovery in the futures market is said to be effective if information flows from futures to spot which is concluded and proved (Kumar, Debashis, & Suresh, 2014)**.** However, another study on cotton futures markets has concluded that there is very little ability of the futures market to anticipate cotton spot prices (Samal, 2017). Similarly**,** this theory was also proved in sugar futures trading which might be due to low trading volume. It was assumed that low trading volume implied a relatively small amount of information and hence such markets were inefficient (Shihabudheen & Padhi, 2010).Price unpredictability was the major consequence of different variables which impacted the cost of agribusiness items (Nanda & Bavishi, 2021). A study observed that various complexities were involved in derivative trading which pulled the farmers back from involving in active trading (Venkatragavan & Sivasakkaravarthi, 2022)**.** Marginal maize farmers' inability to participate in the market was hindered by several factors, including poor road infrastructure, a lack of loan options, insufficient extension agents, subpar storage facilities, and a lack of production inputs (Omotayo, Olugbenga, Olarotimi, & Oladele, 2020). A similar study conducted in Africa concluded that greater transaction costs, imperfect facts, and inadequate markets contributed to ineffectiveness in agrarian markets, indicating the necessity for robust non-market organizations to stimulate solid and effective exchange(Coulter & Onumah, 2002)**.** Several recommendations were suggested such as revamping the marketing process, improvising governance, empowering farmers, and facilitating private-public partnership models. It was expected that the above-stated measures would lead the commodity derivatives market to strengthen and support the agricultural sector of India(Ahmad & Jamshed, 2014)**.** Frequent awareness programs for farmers were needed for the benefit as well as the operational process of commodities derivatives (Yadav, Tripathi, & Shastri, 2017).The review of prior research encouraged further investigation into the efficiency of price discovery in the Indian maize futures market.

Data And Methodology: -

Data: -

The National Commodity and Derivatives Exchange (NCDEX) is chosen for analyzing the price discovery efficiency of the Indian commodity futures market for maize because it is regarded as the premier commodity exchange for agricultural commodities at the national level. The period selected for thisresearch was the futures contracts expiring from April 2020 to March 2022. The sample used for this study comprised one agricultural commodity i.e. Maize transacted on the NCDEX. The data included daily closing futures and spot prices for maize during the study period. The maize futures price is acquired from the NCDEX website (www.ncdex.com) and its spot prices are collected from Agmarknet (www.agmarknet.gov.in). Table 1 here shows the facts of sample futures contracts. There are 24 contracts on maize with 1406 price observations studied to test the price discovery efficiency.

Table1:- Futures contractsofmaizeduringtheperiod 2020-2022.

Year	**Contract**	**No. of Observations**	**Year**	**Contract**	**No. of Observations**
2020-21	April	26	**2021-22**	April	66

	May	31		May	66
	June	48		June	47
	July	51		July	46
	August	50		August	44
	September	58		September	59
	October	54		October	72
	November	50		November	66
	December	51		December	68
	January	58		January	81
	February	77		February	79
	March	77		March	81

Source: www.ncdex.com

Methodology:-

To minimize abnormal profits from price arbitrage, an effective futures market must promptly provide price indications to the spot market. Alternatively, at maturity, the spot prices should be equal to the futures prices, with the exception of minor transaction expenses. Equation (1) can be used to express the effectiveness of Indian agricultural futures markets using carrying costs and no-arbitrage profit expectations:

$$F_{t,t-p}=S_{t-p}+c_t \quad \ldots(1)$$

where c_t stands for the cost-of-carry, $F_{t,\, t-k}$for the price of the futures contract at the time 't' for delivery at the time 't-p, and $S_{t-p}$for the anticipated spot price at the contract's maturity, which is time t-p. The arbitrage model deduces that the futures price is co-integrated with the spot price if the cost-of-carry is constant or zero.Twofold crucialconditionsshouldbefulfilledto confirm the long-run efficiency of maize futuresmarkets in India, viz. S and F should be integrated in similarorderandtheyshouldlikewisebeco-integrated, elseSand Fshalltend todriftaway from each otherover theperiod.

StationarityTest

The stationarity test is crucial as regressing non-stationary series on each other could result in erroneous findings. Therefore, stationarity should be present in the variables anticipated for use in the regression model. Even though the majority of the underlying price series are introduced to be non-stationary at level, their first differences are shown to be stationary,i.e.I(1). The moments will fluctuate over time if the time series is non-stationary.For instance, the price over the previous period would impact both the mean and variance. The mean and variances will be affected by changes in previous price moments (Sarkar, 2015). Additionally, stationary time series contains a number of useful characteristics for analysis. Therefore, the Augmented Dickey-Fuller (ADF) test has been used in this study to check the stationarity of the current closing price series. The ADF test is identifiedas perEquation (2) here:

$$\Delta Y_t=b_0+ \beta Y_{t-1}+\mu_1 Y_{t-1}+\mu_2 Y_{t-2}+ \ldots\ldots + \mu_p Y_{t-p}+\varepsilon_t \quad \ldots (2)$$

Where, $Y_t$stands for the time series being tested, $b_0$for the intercept term, $\beta$for the unit root test's coefficient of interest, $\mu_i$for the augmented lagged first difference of Y_t tostand for the p^{th}orderautoregressive process, and$\varepsilon_t$for the white noise error term.

The fact that the rejected null hypothesis indicates that the time series data are stationary. The decision criteria depend upon matching the calculated values of the ADF 't' statistic with that of thresholds aimed at rejecting the unit root hypothesis. The null hypothesis of non-stationarity in variables of time series can't be rejected if the estimated ADF statistic is smaller than critical values.

VectorAutoregressiveModel (VAR)

The second stage is to use a VAR model to find the inter-relationship between futures prices and spot prices of chosen commodities once stationarity has been tested. Each variable in a VAR has an equation describing its development subject to its lags as well as the lags of further model variables, and all variables are treated symmetrically in a structural sense. In a VAR model, the evolution of a group of *k* variables over the same sample period (t = 1, T) is defined as a linear function of just their historical data. The variables are put together in a $k \times 1$ vector y_t, with the i^{th}element being the i^{th}variable's time *t* observation. Equation (3) represents a *p-th* order VAR as VAR (p):

$y_t = C + A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + e_t$ … (3)

where,thel-periodsbackobservationy_{t-l}isnamedthel-thlag of y, *C*isa *k×1*vectorofconstants,$A_i$denotesatime-invariant*k×k*matrixand$e_t$denotesa*k×1*vectoroferror-term.

CausalityTest

To examine the course of causation among spot price and futures price, the Granger-causality test is performed. To ascertain if or not the variables of research may be used to forecast one another, the Granger-causality test is applied. According to Granger, variables can be utilized to forecast one another if there is a causal relationship between them. Thecausalitytestaimstodetermineif a uni-directional or bi-directional association subsistsamong futures price and spot price(Dey & Maitra, 2012).To achieve this, the present study uses the Granger-causality test to analyze the statistical causality among the futures price of maize and its spot price along with finding the additional analytical content of one variable further than that intrinsic in the explanatory variable itself. For the Granger causality test, the study employed the daily closing prices of maize futures (F_t) and spot (S_t).Moreprecisely, by approximating the regression models (4) and (5), the Granger causality test elaborated on analyzing the association between $S_t$andplaggedvaluesofS_t andF_t:

$$S_t = a_0 + \sum_{k=1}^{p} a_{1k} S_{t-k} + \sum_{k=1}^{p} a_{2k} F_{t-k} + e_t \quad \dots (4)$$

$$F_t = a_0 + \sum_{k=1}^{p} a_{1k} F_{t-k} + \sum_{k=1}^{p} a_{2k} S_{t-k} + e_t \quad \dots (5)$$

To determine whether F_t does not Granger-cause S_t, the F-test is employed to analyze the null hypothesis that the lagged coefficients of F_t are equal to 0. The reverse effect, or if S_t doesn't Granger-cause F_t, is examined using an identical F-test.

Results and Discussion:-

The estimated ADF "t" statistic values for a total of 24 maize contracts are displayed in Table no. 2 at a 5% level of significance. Unit root tests show that futures and spot prices are stationary in first difference rather than level form. The outcomes are denoted as I (1). This meets the first market efficiency criterion.

Table2:- AugmentedDickey-Fullertest forstationary.

Year	Contract	No. of Observations	Futures 't' statistics (1st Difference)	Futures p Value	Spot 't' statistics (1st Difference)	Spot p Value	Critical 't' at 5%
2020-21	April	26	-3.1793	0.1120	-6.8047	0.0001	-3.61
	May	31	-4.0465	0.0182	-7.1284	0.0000	-3.57
	June	48	-4.9791	0.0011	-8.8825	0.0000	-3.51
	July	51	-5.5234	0.0002	-10.2153	0.0000	-3.50
	August	50	-6.4095	0.0000	-10.9771	0.0000	-3.51
	September	58	-8.4724	0.0000	-9.6968	0.0000	-3.49
	October	54	-8.6913	0.0000	-7.8803	0.0000	-3.50
	November	50	-8.5907	0.0000	-6.7037	0.0000	-3.51
	December	51	-8.5907	0.0000	-7.7675	0.0000	-3.50
	January	58	-9.5271	0.0000	-7.8741	0.0000	-3.49
	February	77	-10.8327	0.0000	-9.2494	0.0000	-3.47
	March	77	-10.0216	0.0000	-10.7366	0.0000	-3.47
2021-22	April	66	-8.0767	0.0000	-11.1609	0.0000	-3.48
	May	66	-7.4627	0.0000	-11.1609	0.0000	-3.48
	June	47	-6.5760	0.0000	-6.0850	0.0000	-3.51

	July	46	-5.617	0.0002	-6.0805	0.0000	-3.52
	August	44	-7.8116	0.0000	-9.2869	0.0000	-3.52
	September	59	-10.216	0.0000	-10.9914	0.0000	3.49
	October	72	-13.1830	0.0001	-10.0842	0.0000	-3.48
	November	66	-11.3374	0.0000	-11.7431	0.0000	-3.48
	December	68	-9.7915	0.0000	-11.0291	0.0000	-3.48
	January	81	-9.9361	0.0000	-11.3081	0.0001	-3.47
	February	79	-6.5158	0.0000	-8.0797	0.0000	-3.47
	March	81	-7.0273	0.0000	-7.9230	0.0000	-3.47

Source:Authors'estimations

With the exception of the April 2020 contract, which is stationary at the second difference, the ADF test shows the estimated value statistics in Table 2, which are all greater in absolute terms as compared to the related critical values at the 5% level of significance. As a result, the null hypothesis that these series are non-stationary and contain a unit root is rejected.

The inter-dependency of the two variables of maize was tested using VAR equations because futures and spot prices are both stationary variables. To obtain the most accurate results while approximating VAR equations, it is essential to comprehend the ideal lag of endogenous variables used as independent variables (in this case, both variables). Table-3showstheobtainedlog-likelihood(LL),likelihoodratio(LR), finalpredictionerror(FPE), Akaike's Information Criteria (AIE), Shwarz Information Criteria (SIC), and Hannan and Quinn Information Criteria (HQIC)estimationsfromthemodelsapproximated with diverse lags for altogether24 contracts.According to theory, when LL and LR are higher and FPE and ICs are lower, a model is strengthened. According to the results, the ideal latency is 1 for 19 contracts, 2 for 4 contracts, and 3 for a single contract.

Table3:- Selectionofoptimallag.

Year	**Contract**	**Lag**	**Log-Likelihood**	**Likelihood Ratio**	**Final Prediction Error**	**Akaike's Information Criteria**	**Shwarz Information Criteria**	**Hannan and Quinn Information Criteria**
2020-21	April	0	-281.0143	NA	59940578	23.58452	23.68269	23.61057
		1	-242.1895	67.94342	3299656.*	20.68245*	20.97697*	20.76059*
	May	0	-352.1601	NA	139000000	24.42484	24.51913	24.45437
		1	-304.3076	85.80451*	6758124.*	21.40052*	21.68341*	21.48912*
	June	0	-538.8012	NA	162000000.	24.58187	24.66297	24.61195
		1	-458.159	150.2878*	4989300.*	21.09814*	21.34144*	21.18836*
	July	0	-518.6158	NA	14333688	22.15386	22.23259	22.18349
		1	-469.7418	91.50888*	2124237*	20.24433*	20.48052*	20.33321*
	August	0	-449.8812	NA	1168542.	19.64701	19.72651	19.67679
		1	-424.3897	47.65793	459187.3	18.7126	18.95112*	18.80195
		2	-417.7825	11.7780*	410532.8*	18.59924*	18.99677	18.74816*
	September	0	-518.8612	NA	1132524	19.6157	19.69005	19.6443
		1	-490.0221	52.44158*	461530.9*	18.71782*	18.94087*	18.80359*
	October	0	-465.8376	NA	673114.9	19.09541	19.17263	19.12471
		1	-445.0134	39.09851*	338833.6*	18.40871*	18.64036*	18.49660*
	November	0	-494.6772	NA	8194075.	21.59466	21.67417	21.62445

		1	-423.0449	133.9214*	433107.2*	18.65412*	18.89264*	18.74347*
	December	0	-533.7515	NA	27294520	22.79794	22.87667	22.82756
		1	-439.7195	176.0600*	592069.7*	18.96679*	19.20298*	19.05567*
	January	0	-581.3821	NA	12467976	22.01442	22.08877	22.04301
		1	-494.8932	163.1866*	554664.3*	18.90163*	19.12468*	18.98741*
	February	0	-744.7132	NA	6318001.	21.33466	21.39891	21.36018
		1	-638.0434	204.1965*	336243.5*	18.40124*	18.59397*	18.47779*
	March	0	-714.9099	NA	2696296.	20.48314	20.54738	20.50866
		1	-627.3815	167.5544*	247945.6*	18.09661*	18.28934*	18.17317*

Year	Contract	Lag	Log-Likelihood	Likelihood Ratio	Final Prediction Error	Akaike's Information Criteria	Shwarz Information Criteria	Hannan and Quinn Information Criteria
2021-22	April	0	-636.7162	NA	6045304.	21.29054	21.36035	21.31785
		1	-510.5098	239.7921*	102889.1*	17.21699*	17.42643*	17.29892*
	May	0	-608.9308	NA	2394328.	20.36436	20.43417	20.39167
		1	-508.6477	190.538	96696.80*	17.15492*	17.36436*	17.23684*
	June	0	-458.0433	NA	6726917.	21.39736	21.47928	21.42757
		1	-381.4576	142.4852*	230033.9*	18.02128*	18.26703*	18.11191*
	July	0	-504.9095	NA	104000000	24.13855	24.22129	24.16888
		1	-413.4518	169.8500*	1621120.	19.97389*	20.22213*	20.06488*
	August	0	-470.5742	NA	62643900.	23.62871	23.71315	23.65924
		1	-404.0623	123.0471*	2752236.*	50311*	20.75645*	20.59471*
	September	0	-621.8956	NA	37188143	23.10725	23.18091	23.13566
		1	-535.5479	163.1013*	1761725.	20.05733	20.27833*	20.14256*
		2	-530.9486	8.346808	1724494*	20.03513*	20.40346	20.17719
	October	0	-741.9412	NA	21166346	22.54367	22.61003	22.56898
		1	-656.4372	163.2349*	1790895.*	20.07385*	20.27291*	20.15251*
	November	0	-658.4907	NA	12492141	22.01636	22.08617	22.04367
		1	-588.8341	132.3475*	1400329.	19.8278	20.03724*	19.90973*
		2	-584.2617	8.382793	1374698.*	19.80872*	20.15778	19.94526
	December	0	-680.1544	NA	12350794	22.00498	22.07360	22.03192
		1	-596.2545	159.6804*	938428.5*	19.42756*	19.63342*	19.50839*
	January	0	-836.398	NA	23763366	22.65941	22.72168	22.68425
		1	-735.3396	193.9230*	1724658*	20.03620*	20.22302*	20.11073*
	February	0	-865.9039	NA	101000000	24.10844	24.17168	24.13362
		1	-738.0892	244.9782	3247797.	20.66915	20.85887*	20.74467*
		2	-732.9617	9.542922*	3148754.*	20.63782*	20.95403	20.76371
	March	0	-901.3735	NA	138000000	24.4155	24.47777	24.44034
		1	-742.6879	304.5047	2103565.	20.23481	20.42163*	20.30933*
		2	-737.8584	9.006370	2057595.	20.21239	20.52375	20.33660
		3	-731.69965	11.15810*	1942216.*	20.15396*	20.58986	20.32785

Source: Authors'estimations

Note: Lags corresponding to the highest number of '* 'marked criteria are considered optimum lag
NA:NotAvailable

After identifying optimal lag, the VAR model was assessed forthe complete set of contracts. In Annexure 1, the results of the VAR model are displayed. Table 4 below provides a clear indication of the VAR model's results.

Table 4:- Summary of VAR Model.

Maize						
Contract	**2020-21**			**2021-22**		
	Equation of	**lag of spot**	**lag of futures**	**Equation of**	**lag of spot**	**lag of futures**
April	Spot	0	0	Spot	p	0
	Futures	0	p	Futures	0	p
May	Spot	0	p	Spot	p	0
	Futures	0	p	Futures	0	p
June	Spot	p	0	Spot	p	0
	Futures	0	p	Futures	0	p
July	Spot	0	p	Spot	p	0
	Futures	0	p	Futures	0	p
August	Spot	0	0	Spot	p	0
	Futures	0	0	Futures	0	p
September	Spot	0	0	Spot	p	0
	Futures	0	p	Futures	0	p
October	Spot	p	0	Spot	p	0
	Futures	0	p	Futures	0	p
November	Spot	p	0	Spot	p	0
	Futures	0	p	Futures	0	p
December	Spot	p	0	Spot	p	0
	Futures	0	p	Futures	0	p
January	Spot	p	0	Spot	p	0
	Futures	0	p	Futures	0	p
February	Spot	p	0	Spot	0	0
	Futures	0	p	Futures	0	p
March	Spot	p	0	Spot	p	0
	Futures	0	p	Futures	0	0

n=Explanatoryvariablesignificantlyinfluencesdependentvariable in the negative direction,
p = Explanatory variablesignificantlyinfluencesdependentvariableinthepositivedirection,
0 = Explanatory variable does not significantlyinfluencethedependentvariable

It is clearly understood from Table no. 4 that in all 24contracts, the lag of the spot doesn't influence futures. However, in 2 contracts, the lag of futures affects the spot progressively, while it does not affect the spot in the other 22 contracts. Therefore, it can be concluded that neither the lag value of futures nor the lag value of spot has a significant influence on the other.

To reaffirm the aforementioned findings, the Granger causality test was used to summarize the link, and the findings are reflected in Table no. 5.

Table 5:- Granger Causality Test results for Maize.

Year	Contract	Hypothesis	F Statistic	Probability	Direction	Relation
2020-21	April	S /→ F	1.23538	0.3130	No direction	S—X— F
		F /→ S	0.67533	0.5208		F—X— S
	May	S /→ F	1.44912	0.2546	Unidirectional	F→ S
		F /→ S	4.85721**	0.0169		

	June	S /→ F	1.72259	0.1913	Unidirectional	F→ S
		F /→ S	4.50076**	0.0171		
	July	S /→ F	0.30933	0.7355	Unidirectional	F→ S
		F /→ S	6.12133*	0.0045		
	August	S /→ F	3.14718***	0.0530	Bidirectional	F↔S
		F /→ S	3.79469**	0.0304		
	September	S /→ F	0.154508	0.2231	No direction	S—X— F
		F /→ S	1.59667	0.2125		F—X— S
	October	S /→ F	2.03472	0.1421	No direction	S—X— F
		F /→ S	0.54579	0.5830		F—X— S
	November	S /→ F	2.45228***	0.0981	Bidirectional	F↔S
		F /→ S	2.60288***	0.0857		
	December	S /→ F	2.73796***	0.0757	Unidirectional	S→ F
		F /→ S	0.05091	0.9504		
	January	S /→ F	3.12733***	0.0523	Unidirectional	S→ F
		F /→ S	0.23294	0.7930		
	February	S /→ F	3.24452**	0.0449	Unidirectional	S→ F
		F /→ S	0.15058	0.8605		
	March	S /→ F	2.11559	0.1282	No direction	S—X— F
		F /→ S	0.09223	0.9120		F—X— S
2021-22	April	S /→ F	2.23385	0.1161	No direction	S—X— F
		F /→ S	1.96575	0.1493		F—X— S
	May	S /→ F	0.67018	0.5155	No direction	S—X— F
		F /→ S	0.45587	0.6361		F—X— S
	June	S /→ F	5.36483*	0.0086	Unidirectional	S→ F
		F /→ S	0.86616	0.4283		
	July	S /→ F	4.29699**	0.0206	Unidirectional	S→ F
		F /→ S	1.0056	0.3751		
	August	S /→ F	4.63153**	0.0160	Unidirectional	S→ F
		F /→ S	1.40663	0.2578		
	September	S /→ F	5.08163*	0.0096	Unidirectional	S→ F
		F /→ S	1.20078	0.3092		
	October	S /→ F	3.72487**	0.0294	Unidirectional	S→ F
		F /→ S	0.88957	0.4158		
	November	S /→ F	1.8515	0.1660	Unidirectional	F→ S
		F /→ S	2.64531***	0.0794		
	December	S /→ F	1.37767	0.2599	Unidirectional	F→ S
		F /→ S	3.8185**	0.0274		
	January	S /→ F	4.57085**	0.0134	Unidirectional	S→ F
		F /→ S	0.84415	0.4340		
	February	S /→ F	3.32366**	0.0416	Bidirectional	F↔S
		F /→ S	0.35964**	0.0416		
	March	S /→ F	3.61344**	0.0318	Unidirectional	S→ F
		F /→ S	1.47235	0.2360		

Source: Authors' estimations.
Note: *1 percent, **5 percent significance, ***10% significance, F-statistic reported. In the last column F and S indicate Futures and Spot prices while the symbol → and —X—, respectively indicate Granger cause and does not Granger cause

The top and bottom rows of the F statistic column, respectively, present the null hypotheses that neither spot prices nor futures prices are Granger-caused by one another.At the 5% and 10% level of significance, the null hypothesis that the prices in the futures market do not Granger-cause the prices in the spot market is often continuously rejected for 8 out of 24 contracts. It also takes into account the fact that for 10 out of 24 contracts, the null hypothesis that spot prices do not Granger cause the prices in the futures market is uniformly rejected at 1%, 5%, and 10% significance levels.Furthermore, it has been demonstrated that the bidirectional causal relationship (F ←→S) results in just three contracts. Additionally, the test shows no directional correlation between spot prices and futures prices in 6 contracts.Therefore, the study of the F statistics for all the contracts shows conclusive evidence that even while there is a cause-and-effect link between the futures price and spot price of maize for a small number of contracts, they do not significantly influence one another. However, compared to the influence of the spot market on the futures market, the latter has little impact on the former.Consequently, it may be concluded that the maize futures market is inefficient since it takes too long to convey price signals to the spot market in order to lower supernormal profits through price arbitrage.

Conclusion:-

The study initiates with the analysis of the role of maize in the Indian context and further uses a variety of statistical tools to conduct an empirical analysis to determine whether the maize futures market satisfies the market efficiency requirement or not. The results indicate that there is no clear linear relationship between the price of maize in the spot market and the futures market. Also, the lag value of maize futures has no impact on the spot, as the VAR model has amply demonstrated. Strong proof that futures market prices do not precede spot market prices or that the spot prices aren't made known in the futures markets has been presented via the Granger causality test. Thus, it may be argued that there is not any visible correlation between the spot price of maize and its futures price, suggesting that the maize commodity futures market in India is inefficient.

Although many factors contribute to the maize futures market's inefficient operation, the exchange-specific issues that could be inferred from the capacity of trading in maize futures contracts, such as less market penetration and tiny volume, erratic trading, absence of active involvement from trading fellows, and so on, can be seen as the market's main issues. Other potential reasons for such inefficiency include farmers' lack of knowledge about futures markets, underdeveloped spot markets nearby, a lack of well-established grading and standardizing systems, etc. The competence of the maize futures market can be increased, as indicated by (Easwaran & Ramsundaram, 2008) if such issues can be solved through appropriate policy outlooks.

Policy Implications

1. Policy actions ought to be taken to intensify market depth, consistent and activeinvolvement of trading participants, grading as well as standardization arrangement of maize.
2. Appropriate steps must be done to change the focus of the current "Production-Oriented Extension" strategy in maize to "Market-Oriented Extension" to raise awareness among farmers and other stakeholders about the derivatives market.
3. Appropriate programmes have to be planned for the capacity development of farmers' societies by commercial associations, regulated market agencies, Non-governmental organizations, SHGs, and the rest for their effective involvement in the futures market.
4. Customizing the lot size of the maize futures contract is necessary to encourage small and marginal farmers to participate in the futures market.
5. Agrarians should hold a position on commodity exchanges by creating minor groups as well as bringing together their harvests.
6. Trustworthy and popular warehouse operatives supported by government principles must be established to mark the structure as convenient and in operation meant for the agriculturalists.

Acknowledgements:-
The present research work is an outcome of a funded project by the Indian Council of Social Sciences Research (ICSSR). The perfections suggested by the referee and editor are gratefully acknowledged.

Annexure 1
VAR (Vector Auto Regression) MODEL

Year	**Independent Variable**							
	Contract	**Equation of**	**One Lag of SP**	**Two Lags of SP**	**Three Lags of SP**	**One Lag of FP**	**Two Lags of FP**	**Three Lags of SP**
2020-21	**April**	SP	1.72 (0.10)			0.10 (0.85)		
		FP	0.56 (0.58)			**5.75 (0.00)**		
	May	SP	0.93 (0.28)			**2.54 (0.02)**		
		FP	-1.32 (0.08)			**6.30 (0.00)**		
	June	SP	**1.98 (0.05)**			1.95 (0.06)		
		FP	-1.16 (0.25)			**8.55 (0.00)**		
	July	SP	0.46 (0.65)			**2.53 (0.01)**		
		FP	-0.79 (0.44)			**7.11(0.00)**		
	August	SP		1.35 (0.18)			2.66 (0.12)	
		FP		-1.01 (0.32)			-1.37 (0.18)	
	September	SP	3.39 (0.09)			0.13 (0.89)		
		FP	1.74 (0.09)			**5.07 (0.00)**		
	October	SP	**4.83 (0.00)**			-1.02 (0.31)		
		FP	1.63 (0.11)			**4.12 (0.00)**		
	November	SP	**6.40 (0.00)**			0.84 (0.10)		
		FP	1.57 (0.12)			**4.59 (0.00)**		
	December	SP	**5.32 (0.00)**			0.32 (0.75)		
		FP	1.25 (0.22)			**4.15 (0.00)**		
	January	SP	**6.07 (0.00)**			0.00 (0.10)		
		FP	0.76 (0.45)			**3.77 (0.00)**		
	February	SP	**6.98 (0.00)**			0.00 (0.12)		
		FP	0.63 (0.53)			**5.32 (0.00)**		
	March	SP	**5.72 (0.00)**			0.21 (0.83)		
		FP	0.37 (0.71)			**6.06 (0.00)**		
2021-22	**April**	SP	**3.95 (0.00)**			1.05 (0.30)		
		FP	0.23 (0.82)			**7.19 (0.00)**		
	May	SP	**4.36 (0.00)**			0.16 (0.87)		
		FP	0.22 (0.83)			**7.57 (0.00)**		
	June	SP	**5.11 (0.00)**			1.20 (0.24)		
		FP	1.94 (0.06)			**4.50 (0.00)**		
	July	SP	**6.30 (0.00)**			1.40 (0.17)		
		FP	-0.05 (0.96)			**4.40 (0.00)**		
	August	SP	**2.58 (0.01)**			1.09 (0.28)		
		FP	1.41 (0.17)			**3.69 (0.00)**		

	September	SP	**3.10 (0.00)**			0.87 (0.39)		
		FP	-1.65 (0.11)			**3.96 (0.00)**		
	October	SP	**3.53 (0.00)**			0.83 (0.41)		
		FP	1.70 (0.09)			**3.96 (0.00)**		
	November	SP	**3.30 (0.00)**			1.24 (0.22)		
		FP	1.56 (0.12)			**4.77 (0.00)**		
	December	SP	**3.87 (0.00)**			1.95 (0.06)		
		FP	1.37 (0.17)			**5.62 (0.00)**		
	January	SP	**5.91 (0.00)**			1.22 (0.22)		
		FP	1.68 (0.10)			**6.22 (0.00)**		
	February	SP		1.58 (0.11)			-0.56 (0.58)	
		FP		0.18 (0.86)			**-2.55 (0.01)**	
	March	SP			**2.43 (0.02)**			0.65 (0.52)
		FP			1.04 (0.30)			-1.06 (0.29)

References:-

1. Adrian, F.-P., Bart, F., Ilnara, G., & Alireza, T.-R. (2021). Profit margin hedging in the New Zealand dairy farming industry. Journal of Commodity Markets. doi:https://doi.org/10.1016/j.jcomm.2021.100197
2. Ahmad, S., & Jamshed, M. (2014). Nurturing an agriculture friendly commodity derivatives marketing in India. MITS International Journal of Business Research, 1(1).
3. Amitha, C. D., Savitha, B., Rani, S. V., & Laxminarayana, P. (2021). Evaluation of Performance of Farmer Producer Organizations (FPOs) in Medak District of Telangana State. Indian Research Journal of Extension Education, 24(4), 24-29.
4. B, B. S., Wouter, V., G, W. M., Kolandavel, N., & Van, D. P. (2020). Vulnerability to climate change among maize-dependent smallholders in three districts of Ethiopia. Environment, Development and Sustainability, 22, 693-718.
5. Cariappa, A. A., Acharya, K. K., Yadav, C. A., Ramadas, S., & Ramasundaram , P. (2021). Impact of COVID-19 on the Indian agricultural system: A 10-point strategy for postpandemic. Outlook on Agriculture, 50(1), 26-33. doi:10.1177/0030727021989060
6. Ceballos, F., Kannan, S., & Kramer, B. (2020). Impacts of a national lockdown on smallholder farmers' income and food security: Empirical evidence from two states in India. World Development, Elsevier, 136. doi:https://doi.org/10.1016/j.worlddev.2020.105069
7. Coulter, J., & Onumah, G. (2002). The role of warehouse receipt systems in. Food Policy, 27, 319-337.
8. Dey, K., & Maitra, D. (2012). Price discovery in Indian commodity futures market: an empirical exercise. International Journal of Trade and Global Markets, 5(1), 68-87.
9. Easwaran, R. S., & Ramsundaram, P. (2008). Whether commodity futures market in agriculture is efficient in price discovery? - An econometric analysis. Agricultural Economics Research Review, 21, 337-344.
10. Faridi, M. Z., Ahmad, R., & Bashi, F. (2021). Socio-Economic Status of Farming Community: A Case of District Rajanpur. Review of Applied Management and social sciences, 4(2), 485- 494.
11. G, B., & N, S. P. (2006). Futures for farmers: Hedging participation and the Mexican corn scheme. The Journal of Development Studies, 42(4). doi:https://doi.org/10.1080/00220380600682330
12. Gloria, B., Adrian, C., & Camilo, S. J. (2020). Managing colombian farmers price risk exposure with electrical derivatives market. Heliyon. doi:https://doi.org/10.1016/j.heliyon.2020.e05713
13. Inderpal, S. (2015). Impact of Derivatives on Spot Market Volatility : A Case of Indian Agriculture Commodity. FIIB Business Review, 4(3).
14. Jerzy, M., Pavel, C., & Jan, P. (2017). The impact of producer organisations on farm performance: A case study of large farms in Slovakia. Publications Office of the European Union. EUR 28793 EN: EUR 28793 EN.

15. Kolte, A., Deshmukh, S., & Gidwani, M. (2019). Socio- Economic state of Farmers in the state of Maharashtra. Adalya Journal, 8(8).
16. Kumar, M. M., Debashis, A., & Suresh, B. M. (2014). Price discovery and volatility spillovers in futures and spot commodity markets Some Indian evidence. Journal of Advances in Management Research, 11(2), 211-226. doi:https://doi.org/10.1108/JAMR-09-2012-0039
17. Kumar, M. P., Singh, R. J., Pandey, D. K., Singh, R., Jadav, N. B., & Rajput, R. B. (2016). Problems Faced by the Farmers in Adoption of Mitigation and Adaptation of Climate Change Practices in Agriculture. International Journal of Agriculture Sciences, 8(56), 3086-3088.
18. Massimo, P., Lucia, B., & Daniela, V. (2013). Price discovery in commodity markets. Applied Economics Letters, 20(4), 397-403. doi:10.1080/13504851.2012.709590
19. Mehedi, A. K., Anindita, S. S., Zannat, T. R., & Prithila, P. (2021). Profit efficiency and influencing factors for the inefficiency of maize production in Bangladesh. Journal of Agriculture and Food Research, 5.
20. Mohanty, S. K., & Mishra , S. (2020). Regulatory reform and market efficiency: The case of Indian agricultural commodity futures markets. Research in International Business and Finance. doi:10.1016/j.ribaf.2019.101145
21. Movahedi, R., Jawanmardi, S., Azadi, H., Goli, I., Viira, A.-H., & Witlox;, F. (2021, September). Why do farmers abandon agricultural lands? The case of Western Iran. Land Use Policy, 108.
22. Nanda , L., & Bavishi, H. (2021). Awareness of Commodity Derivative Among Farmers. International Journal of Business and Management Invention (IJBMI), 10(8), 72-78.
23. Nazari, N. S., Hossein, A., Luuk, F., Kristina, J., Petr, S., & Frank, W. (2022). Social, economic and environmental vulnerability: The case of wheat farmers in. Science of the Total Environment, 816.
24. Neharika, S. (2020). Determinants of a successful commodity contract: Evidence from the Indian agriculture futures market. IIMB Management Review. doi:https://doi.org/10.1016/j.iimb.2021.01.001
25. Omotayo, A. O., Olugbenga, O. A., Olarotimi, & O. N. (2020). Economic market decisions among marginal maize farmer in Abuja, Nigeria: Application of double Hurdle Model and Factor analysis. Russian Journal of Agricultural and Socio-Economic Sciences, 104(8). doi:10.18551/rjoas.2020-08.14
26. Prakash, S. R., & C, V. (2021). Risk Analysis of Spot and Futures Prices of Maize. The IUP Journal of Financial Risk Management, 18(2), 39-63.
27. Reddy, G., N. Gangisetty, & Reddy, T. (2015). A Study on Socio Economic Conditions of Farmers in Kurnool District. MERC Global's International Journal of Social Science & Management, 2(4), 281-288.
28. Ruchika, K., Nawal, K., & Namita, R. (2018). Price Discovery and Volatility Spillovers: Evidence from Non-Agricultural Commodity Market in India. IUP Journal of Financial Risk Management, 15(3).
29. Ruerd, R., & Fernando, S. (2008). Farmers, Markets and Contracts: Chain Integration of Smallholder Producers in Costa Rica. European Review of Latin American and Caribbean Studies.
30. S.J., B., Kishore, P., Raka, S., P, S. N., & Denny, F. (2020). Technology-Policy Tradeoff in Doubling Farmers' Income: A Case Study on Pulses. Agricultural Economics Research Review, 30, 117-126.
31. Salim, S. (2021). Financialisation of commodities – Empirical evidence from the Indian financial market. IIMB Management Review, 33(1), 38-49. doi:https://doi.org/10.1016/j.iimb.2021.03.001
32. Samal, G. P. (2017). Price Discovery Efficiency of Cotton Futures Market in India. Agricultural Economics Research Review, 30(2), 235-244. doi:10.5958/0974-0279.2017.00045.3
33. Sarkar, S. (2015). Revisiting Random Walk Hypothesis in Indian Stock Market- An Empirical Study on Bombay Stock Exchange. Business Studies, 35 & 36, 55-70.
34. Shang, Y., & Xiong, T. (2021). The impact of farmers' assessments of risk management strategies on their adoption willingness. Journal of Integrative Agriculture, 3323-3338. doi:https://doi.org/10.1016/S2095-3119 (21)63749-8
35. Shihabudheen, M. T., & Padhi, P. (2010). Price Discovery and Volatility Spillover Effect in Indian Commodity Market. Indian Journal of Agricultural Economics, 65(1), 1-17. doi:10.22004/ag.econ.204672
36. Shoaib, A., LI, G.-c., Raza, U., Adnan, N., Amjed, I. M., Raza, M. H., . . . Muhammad F. (2018). Farmers influencing hybrid maize farmers' risk attitudes and their perceptions in Punjab Province, Pakistan. Journal of Integrative Agriculture, 17(6), 1454-1462.
37. Sneha, K., Nisha, B., & K, T. K. (2021). Strengthening Agriculture Value Chain through Collectives: Comparative Case Analysis. International Journal of Rural Management. doi:https://doi.org/10.1177/0973005221991438
38. Soekardjo, H. K., Ndzifon, K. J., & Jurgen, P. (2021). How do smallholder forest farmers' organizations manage and commercialize wood products? – A global systematic review. Forest Policy and Economics. doi:https://doi.org/10.1016/j.forpol.2021.102460
39. Sumathy, M., Shankar, B. P., Sumathy, M., & Charles, A. (2016). Price Discovery in Commodity Market – An Empirical Study on the Silver Market. IOSR Journal of Economics and Finance (IOSR-JEF), 7(2), 88-95. doi:10.9790/5933-0702038895

40. Venkatragavan, V., & Sivasakkaravarthi, P. (2022). An Evaluation Of Farmers' Perception On Agricultural Commodity Derivatives. Journal of Positive School Psychology, 6(2), 3514–3520.
41. Yadav, N., Tripathi, R., & Shastri, R. K. (2017). Study of farmers' investment pattern in commodity derivative in India: With special reference to Allahabad district. National Journal of Multidisciplinary Research and Development, 2(3), 18-21.