EFFICIENCY IN AGRICULTURAL COMMODITY FUTURES MARKETS IN INDIA: AN EMPIRICAL ANALYSIS

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Abstract

In line with the ongoing global and domestic reforms in agriculture and allied sectors, the government is reducing its direct market intervention and encouraging private participation based on market forces. This has led to increased exposure of agricultural produce to price and market risks which consequently emphasizes the importance of future markets for price discovery and price risk management. This paper analyses the efficiency of agricultural commodity markets by assessing the relationships between future prices and spot market prices of major agricultural commodities in India through Johansen's cointegration analysis. Unit root test procedures such as Augmented Dickey-Fuller (ADF) and non-parametric Phillips-Perron (PP) are initially applied to examine whether future and spot prices are stationary or not. The hypothesis, that future prices are unbiased predictors of spot prices for major agricultural commodities traded at NCDEX, has been tested using above techniques using Eviews-Econometric Software. Results show that cointegration in future and spot prices significantly exist for all the agricultural commodities tested except wheat and rice.

Key words: Agriculture, Commodity futures, Market efficiency, Cointegration, India

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1. INTRODUCTION

The agricultural production system has undergone profound changes over the decades due to adoption of green revolution technologies coupled with price support policy of the government (Chand, 2003). As a result, India has moved from food deficit nation to food surplus nation. The production, supply and distribution of many agricultural commodities are still influenced by the government regulations (Sahadevan, 2002). The future commodity trading has a long history in India and started as early as 1857 for Cotton (Kolamakar, 2003; Thomas, 2003; Ahuja, 2006). Commodity future trading in India remained in a state of hibernation for nearly four decades due to doubts about the benefits of derivatives and fear of unnecessary speculation in essential commodities (Ahuja, 2006). After independence, various policy initiatives for protecting agriculture sector adversely affected the agricultural commodities markets. The Essential Commodities Act 1955 envisaged price and movement protection to various agricultural commodities, particularly foodgrains such as paddy, wheat, coarse grains and pulses to protect the interest of producers as well as consumers.

In the process of economic liberalization, it was felt that there is a need to re-orient policies and regulations in agricultural commodities. The Khusro Committee (1980) recommended reintroduction of futures trading in most of the major commodities. The Government of India constituted one more committee headed by Prof. K.N. Kabra in June 1993 on Forward Markets, which emphasized the introduction of future trading in 17 commodity groups covering wide range of agricultural commodities. It also recommended strengthening of the Forward Markets Commission and various amendments in Forward Contracts (Regulation) Act 1952 to bring fairness and efficiency in future trading operations.

The National Agriculture Policy announced in July 2000 envisaged external and domestic market reforms by putting in place a mechanism of futures trade/ market and dismantling of all control and regulations in agricultural commodity market (Sahadevan, 2002). As a result, the Government of India issued notifications on April 1, 2003 and permitted futures trading in a wide range of agricultural commodities except options

trading. At present, there are 3 national level commodities exchanges namely National Multi-Commodity Exchange of India (NMCE), National Commodity and Derivatives Exchange Ltd (NCDEX) and Multi Commodity Exchange of India Ltd (MCX) and 21 regional exchanges allowed for derivatives trading of agricultural commodities.

Distress sales of agricultural commodities due to lack of farmers' capacity to wait for remunerative prices and uncertainty over prices have always been major concerns of the producers as well as consumers (Singh, 2001; Acharya, 2001; Sahadevan, 2002). As highlighted in literature, future contracts perform two important management functions, i.e., price discovery and price risk management for the specific commodity (Sahadevan, 2002; Thomas, 2003; Ahuja, 2006). It is useful for producers as they get an idea about the prices likely to prevail at a future point of time and hence, can decide among various competing commodities for optimizing their profits. It also provides food processors and consumers an idea about prices at which the specific commodity would be available at a future point of time.

Almost four years have passed since the future trading of large number of agricultural commodities was initiated in the year 2003. It is imperative to explore whether the futures market has really been able to achieve its above stated objectives or not. There are very few studies that have explored the efficiency of the commodity future market in India, especially at individual commodities level. Therefore, major objective of the present study is to explore the efficiency of agricultural future markets in India at major agricultural commodities level. The specific research questions that were explored to achieve the above objective are:

- How much is the variation in spot and future prices for various agricultural commodities?
- Are the futures prices of agricultural commodities in India cointegrated with spot prices?

2. DATA AND METHODOLOGY

The daily closing future prices for 12 major agricultural commodities were collected from National Commodity and Derivatives Exchange Ltd (NCDEX) for the period of about last three years. The commodities selected for the study are wheat, rice, maize, chickpea, urad, masur, guarseed, pepper, cashew, castor seed, soybean and sugar, which represent more than 75 percent of total future trading among agricultural commodities in terms of

value at NCDEX. The daily closing prices of these commodities in spot markets were also collected from NCDEX website for the same period for markets, which were also the place of delivery under future contracts for respective commodities (Appendix A).

The descriptive statistics such as mean, standard deviation and coefficient of variation for spot and future prices for various commodities have been estimated and are presented in Table 1. One-way analysis of variance (ANOVA) was performed to test the equality of means of spot price and future price for each commodity. The values of F-statistic along with corresponding p-values are also included in the same table.

Patterns in future and spot prices for various commodities were analyzed through their graphical representation (Apendix B). The literature survey indicates the increasing use of cointegration tests for studying the efficiency of future markets (Chowdhury, 1991; Lai and Lai, 1991; Crowder and Hamed, 1993; Beck, 1994; Kellard et al, 1999; Yang et al, 2001; McKenzie et al, 2002; McKenzie and Holt, 2002; Kellard, 2002; Liu, 2004; Wang and Ke, 2005). The cointegration between the spot price and future price is a necessary condition for market efficiency. It ensures that there exists a long-run equilibrium relationship between the two series. The absence of cointegration indicates that future price provides little information about movement of the cash price, indicating that the future market is not very efficient. The same approach has been used in the current study. As precondition of co-integration analysis, unit root tests based on Augmented Dickey-Fuller (ADF) and non-parametric Phillips-Perron (PP) approaches were used to examine whether the future and spot price series are stationary or not. Finally, the efficiency of future markets for different commodities were tested based on cointegration tests using econometric software Eviews.

3. AGRICULTURAL PRICE VOLATILITY

Price variability is a major component of market risk for both producers and consumers (Schnepf, 1999; World Bank, 1999). Government plays an important role in administering agricultural prices in India through market intervention mechanism. The liberalization of agricultural market in recent decades has provided both opportunities and challenges to producers, traders, consumers and participants in future markets. The reduction in government intervention has increased the price and market risk exposure. It has been argued that as far as there is government intervention in agricultural

commodities market in terms of minimum support prices and procurement guarantees, the forward and future markets for hedging price risk in these commodities have limited role to play (Naik and Jain, 1999; Sahadevan, 2002). An assessment of marketed surplus and share of the government procurement indicates that a major chunk of foodgrains, more than 70% of marketed surplus, is traded in open market arrangement. Apart from this, the government market intervention is limited to some foodgrains only and that too has reduced over time (Jha and Srinivasa, 1999; Gulati et al, 2000; Ramasawamy, 2002; Chand, 2003). In such situations, the role of future market for agricultural commodities become important in price discovery and risk management.

Table 1: Descriptive Statistics for Daily Spot and Future Prices (Rs. / quintal)

Commodity	Mean	Minimum	Maximum	Standard Deviation	CV (%)	F-Value	p-value
Wheat						9.021*	0.000
Spot price	848.6	667.2	1165.7	123.9	14.6		
Future price	842.2	668.6	1149.6	105.6	12.5		
Rice						3.473*	0.000
Spot price	887.4	769.0	1281.3	118.8	13.4		
Future price	1055.5	853.0	1258.0	114.5	10.8		
Maize						90.202*	0.000
Spot price	588.6	505.9	832.5	73.3	12.5		
Future price	593.1	5075	845.0	84.3	14.2		
Chickpea						68.082*	0.000
Spot price	2066.1	1431.2	3326.3	510.5	24.7		
Future price	2084.2	1464.0	3318.0	501.2	24.0		
Urad						28.431*	0.000
Spot price	2433.6	1367.0	4104.0	840.7	34.5		
Future price	2373.1	1355.0	4044.0	747.5	31.5		
Masur						16.824*	0.000
Spot price	1815.0	1535.3	2015.5	105.6	5.8		
Future price	1834.4	1540.0	2026.0	116.7	6.4		
Guar seed						45.745*	0.000
Spot price	1626.9	758.0	2320.8	237.7	14.6		
Future price	1711.4	1024.0	2529.0	263.1	15.4		
Pepper						270.406*	0.000
Spot price	7657.4	5839.2	13800.5	1845.8	24.1		
Future price	7957.3	5444.0	16068.0	1995.3	25.1		
Cashew						3.178*	0.030
Spot price	4818.8	4225.0	5654.2	372.7	7.7		
Future price	4944.7	4300.0	5792.0	471.0	9.5		
Castor seed						15.056*	0.000
Spot price	324.1	277.3	406.8	31.3	9.7		
Future price	332.5	273.5	455.0	34.6	10.4		
Soybean						11.271*	0.000
Spot price	1260.2	1097.0	1442.0	69.6	5.5		
Future price	1293.7	1107.5	1501.7	77.3	6.0		
Sugar Grade M						6.168*	0.000
Spot price	1835.2	1568.9	2106.8	123.9	6.7		
Future price	1839.5	1567.0	2166.0	126.0	6.9		

* significant at 0.05 level

Table 1 summarizes simple descriptive statistics and variability of spot and future prices in terms of coefficient of variation for major agricultural commodities. While variability exists across commodities and between future and sport prices for the same commodity,

variation is more in the former level. Out of 12 commodities analyzed, coefficients of variation in spot and future prices for 5 commodities (masur, cashew, castor seed, soybean and sugar) are less than 10 percent; between 10-20% for 4 commodities (wheat, rice, maize and guar seed); between 20-30% for 2 commodities (chickpea and pepper) and more than 30% for one commodity (urad). The analysis of variance indicates that for all the commodities, there are significant differences between mean value of future and sport prices.

4. EFFICIENCY IN FUTURE MARKET

Future commodity exchange provides a centralized marketplace where market users can discover the prices of commodities for future delivery and where risk-averse people can shift commodity price risk to others willing to bear it (Schap and Dan, 2003). Derivatives, futures, options and swaps provide several economic benefits, primarily the provision to mitigate the inevitable risk of price volatility (Sahdevan, 2002; Robinson, 2003). The use of market based price instruments to mitigate price risk provides farmers with new alternatives for availing credit and insurance facilities and allows them greater certainty in planning their on-farm activities (Varangis, 2003).

In an efficient commodity market, the future price is considered to be an optimal forecast of the spot price at contract termination (Kellard, et al., 1999). The market efficiency evaluation under cointegration analysis recognizes that time series for spot and future prices are usually non-stationary variables (Shen and Wang, 1990; Fortenbery and Zapata, 1993; Wang and Ke, 2005) and if these series are found to be nonstationary, then it is necessary to test for cointegration as a precondition for market efficiency and unbiasedness (Kellard et al, 1999). A finding of no cointegration between spot and futures prices is normally interpreted to imply either market inefficiency or that the (spot and futures) markets do not represent the same underlying asset. The absence of cointegration means the violation of the necessary condition for the simple efficiency hypothesis, which implies that the futures price is not an unbiased predictor of the spot price on maturity (Chowdhury, 1991; Krehbiel and Adkins, 1993; Crodwer and Hamed, 1993; Silvapulle and Moosa, 1999). This follows from the absence of a long-run relationship between spot and futures prices.

The augmented Dickey-Fuller and Phillips-Perron Unit Root Tests are used to examine the stationarity of spot and future prices. These two methods have been adopted to

assess the unit root test using parametric and non-parametric approaches. Table 2 presents the result of unit root tests for major agricultural commodities by both the approaches. The null hypothesis of a unit root is not rejected for the spot and future prices in most of the commodities except Guar seed, where unit root hypothesis is accepted for spot prices at 0.05 level of significance and future prices at 0.10 level of significance.

Table 2: Unit root test on spot and future prices of selected agricultural commodities

Commodities	Augmented Dickey-Fuller (ADF)		Phillips-Perron (PP)	
	Level	1st Difference	Level	1st Difference
Wheat				
Spot price	-0.91 (0.785)	-19.58* (0.000)	-0.83 (0.809)	-19.42* (0.000)
Future price	-0.16 (0.940)	-28.25* (0.000)	-0.32 (0.919)	-28.14* (0.000)
Rice				
Spot price	0.98 (0.996)	-17.44* (0.000)	0.56 (0.988)	-23.44* (0.000)
Future price	-2.08 (0.249)	-14.89* (0.000)	-1.61 (0.474)	-23.08* (0.000)
Maize				
Spot price	-1.67 (0.441)	-9.87* (0.000)	-1.48 (0.540)	-18.18* (0.000)
Future price	-0.71 (0.842)	-19.19* (0.000)	-0.91 (0.783)	-19.24* (0.000)
Chickpea				
Spot price	-0.93 (0.776)	-23.25* (0.000)	-0.99 (0.755)	-23.26* (0.000)
Future price	-1.02 (0.744)	-25.55* (0.000)	-1.05 (0.734)	-25.56* (0.000)
Urad				
Spot price	-0.86 (0.799)	-21.92* (0.000)	-0.82 (0.811)	-21.84* (0.000)
Future price	-1.18 (0.680)	-23.65* (0.000)	-1.18 (0.684)	-23.64* (0.000)
Masur				
Spot price	-1.87 (0.343)	-14.38* (0.000)	-1.89 (0.332)	-14.40* (0.000)
Future price	-2.08 (0.251)	-16.49* (0.000)	-2.19 (0.207)	-16.50* (0.000)
Guar seed				
Spot price	-3.57* (0.006)	-30.08* (0.000)	-3.62* (0.005)	-30.03* (0.000)
Future price	-2.65** (0.082)	-26.92* (0.000)	-2.85 (0.051)	-26.96* (0.000)
Pepper				
Spot price	-0.13 (0.944)	-11.88* (0.000)	-0.24 (0.929)	-24.95* (0.000)
Future price	-0.78 (0.822)	-12.22* (0.000)	-0.67 (0.850)	-27.44* (0.000)
Cashew				
Spot price	-2.33 (0.162)	-24.46* (0.000)	-2.10 (0.243)	-24.51* (0.000)
Future price	-1.97 (0.298)	-22.68* (0.000)	-1.94 (0.311)	-22.68* (0.000)
Castor seed				
Spot price	-1.61 (0.473)	-22.62* (0.000)	-1.67 (0.443)	-22.62* (0.000)
Future price	-2.43 (0.131)	-19.02* (0.000)	-2.25 (0.187)	-19.03* (0.000)
Soybean				
Spot price	-1.61 (0.472)	-21.89* (0.000)	-1.63 (0.465)	-21.93* (0.000)
Future price	-2.12 (0.236)	-23.63* (0.000)	-2.15 (0.222)	-23.64* (0.000)
Sugar Grade M				
Spot price	-1.67 (0.441)	-20.15* (0.000)	-1.93 (0.318)	-21.02* (0.000)
Future price	-1.87 (0.346)	-29.05* (0.000)	-1.78 (0.389)	-29.05* (0.000)

* significant at 0.05 level, ** significant at 0.10 level,
Note: value in parenthesis indicate MacKinnon (1996) p-values

After testing the pre-condition of non-stationary time series of price information, cointegration test has been carried out to determine the existence of a long-run relationship between the spot and future prices. Market efficiency implies that there should be cointegration to determine that spot prices are reflected in the future prices.

The maximum eigenvalue and trace statistics indicate that null hypothesis of zero cointegrating vectors, r=0, is rejected at 0.05 level of significance for all the commodities except wheat and rice (Table 3). The null hypothesis of reduced rank, r=1, cannot be rejected by both the ? trace and ? max statistics for most of the commodities for which null of r=0 is rejected, except masur, guarseed and cashew at 0.05 level of significance and soybean at 0.10 level of significance. The rejection of reduced rank implies that the data series for these commodities are stationary, despite the earlier conclusion drawn from the unit root tests (Kellard et al, 1999).

Table 3: Johansen's Cointegration Tests Statistics for Selected Agricultural commodities

Commodities	**Trace Statistics**		**Max-Eigen Statistics**	
	l_{trace}	**p-value**	$l_{\max}$	**p-value**
Wheat				
H_0: r=0	8.626	0.4010	8.312	0.3478
H_0: r=1	0.313	0.5752	0.313	0.5752
Rice				
H_0: r=0	8.176	0.4467	7.508	0.4308
H_0: r=1	0.667	0.4138	0.667	0.4138
Maize				
H_0: r=0	16.295*	0.0378	15.093*	0.0369
H_0: r=1	1.201	0.2729	1.201	0.2729
Chickpea				
H_0: r=0	23.857 *	0.0022	22.751*	0.0018
H_0: r=1	1.1062	0.2929	1.1062	0.2929
Urad				
H_0: r=0	23.290*	0.0027	22.627*	0.0019
H_0: r=1	0.663	0.4155	0.663	0.4155
Masur				
H_0: r=0	38.855*	0.0000	34.718*	0.0000
H_0: r=1	4.137*	0.0419	4.137*	0.0419
Guar seed				
H_0: r=0	35.422*	0.0000	27.234*	0.0003
H_0: r=1	8.207*	0.0042	8.207*	0.0042
Pepper				
H_0: r=0	33.271*	0.0000	33.271*	0.0000
H_0: r=1	0.000	0.9985	0.000	0.9985
Cashew				
H_0: r=0	18.297*	0.0184	12.861**	0.0823
H_0: r=1	5.435*	0.0197	5.435*	0.0197
Castor seed				
H_0: r=0	18.717*	0.0158	16.253*	0.0239
H_0: r=1	2.463	0.1165	2.463	0.1165
Soybean				
H_0: r=0	25.805*	0.0010	22.702*	0.0019
H_0: r=1	3.102**	0.0782	3.102**	0.0782
Sugar Grade M				
H_0: r=0	18.225*	0.0189	15.843*	0.0279
H_0: r=1	2.382	0.1227	2.382	0.1227
95% Critical Value				
H_0: r=0	15.494		14.264	
H_0: r=1	3.841		3.841	

* significant at 0.05 level, ** significant at 0.10 level,
Notre: value in parenthesis indicate MacKinnon-Haug-Michelis (1999) p-values

The existence of cointegration between the spot and future prices confirms the first necessary condition for long-term market efficiency. Based on cointegration analysis of futures and sport prices of 12 agricultural commodities in the country, the commodities can be grouped into three categories – no cointegration (wheat and rice), cointegration with null hypothesis of zero cointegrating vectors (maize, chickpea, urad, pepper, castor seed, soybean and sugar) and cointegration with null hypothesis of non zero cointegrating vectors (masur, guarseed, cashew).

Less developed future commodity exchanges, market manipulation by large traders and government regulation may account for the inefficiency or no cointegration in future and spot markets (Yang et al, 2001; Wang and Ke, 2005; Bhar and Hamori, 2006). These reasons for no cointegration in case of wheat and rice in Indian scenario seem to be applicable. However, the long-run relationship between future and spot markets for wheat and rice will become apparent with institutional development in futures market and reduced intervention of the government in these commodities.

Our empirical findings suggest that there is long-term relationship between future and spot prices for majority of agricultural commodities (maize, chickpea, urad, pepper, castor seed, soybean and sugar) under the study. This implies that futures markets have enough ability to predict subsequent spot prices i.e. to discovery prices in spot market for these commodities. The results of this study are very useful to various stakeholders of agricultural commodities markets such as producers, traders, commission agents, commodity exchange's participants and regulators. In the open commodity market, any regulatory initiative on futures market will have its desired impact on cash market (Raju and Karande, 2003).

5. CONCLUSIONS

In the era of globalization and liberalization, Indian agriculture is also responding to reap the benefits. After a prolonged prohibition and stringent regulations, future trading in the country in almost all agricultural commodities with close regulation by the Forward Markets Commission (FMC) under the Ministry of Consumer Affairs and Food & Public Distribution as per rules and regulation of the Forward Contracts (Regulation) Act 1952, has been approved by the government. Within a very short time span of about three years, the future trading in agricultural commodities has become an important platform

for various stakeholders in the commodity market. In case of agricultural commodity market, the government has been playing an important role in stabilizing the market to protect producers as well as consumers. But with the declining government interventions in agricultural commodities market, role of future market in price discovery and price management becomes quite important.

The sustainability of future agricultural commodity market depends on the transparency and efficiency of its functioning in terms of price discovery, price risk management, flexible contact specification, controlling unfair speculation, commodity delivery system and coverage, infrastructural support etc. This study empirically examines the efficiency of future markets for 12 major agricultural commodities widely traded in the commodity exchanges, using Johansen's cointegration approach. Results suggest the existence of long-run equilibrium relationship between future and spot prices for majority of agricultural commodities under study except wheat and rice. This implies that future markets for these commodities are performing quite efficiently. The inefficiency in wheat and rice futures may be because of greater market interventions by the government in terms of minimum support price and procurement.

As majority of the primary stakeholders/ agricultural producers are not able to participate in the agricultural commodity market due to low level of commodity surplus, efficient dissemination of future prices will certainly make them to fetch remunerative prices for their produce. Therefore, integration of different available formal and informal institutions at the local level such as e-kiosks, Self Help Groups (SHGs), cooperatives, banks, warehouses & transportations, government agencies and private participants for expanding future commodity trading and information dissemination may be a viable options for making the future trading a great success in the country.

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Appendix A

Table A-1: Data description used for the study

Commodities	Duration	Number of observation (days)	Place (spot / delivery market)
Wheat	July 06, 2004 to January 19, 2007	646	Delhi
Rice	June 10, 2005 to February 01, 2007	411	Delhi
Maize	January 06, 2005 to January 19, 2007	453	Nizamabad
Chickpea	November 20, 2004 to January 19, 2007	656	Delhi
Urad	July 28, 2004 to January 19, 2007	600	Mumbai
Masur	October 21, 2005 to January 19, 2007	287	Indore
Guar seed	April 12, 2004 to January 25, 2007	845	Jodhpur
Pepper	April 13, 2004 to January 25, 2007	826	Kochi
Cashew	March 29, 2005 to November 20, 2006	457	Kollam
Castor seed	July 23, 2004 to January 24, 2007	518	Disa
Soybean	October 11, 2004 to February 01, 2007	695	Indore
Sugar Grade M	July 27, 2004 to January 25, 2007	751	Muzaffernagar

Appendix B

Figure B-1: Trends in future and spot prices of wheat

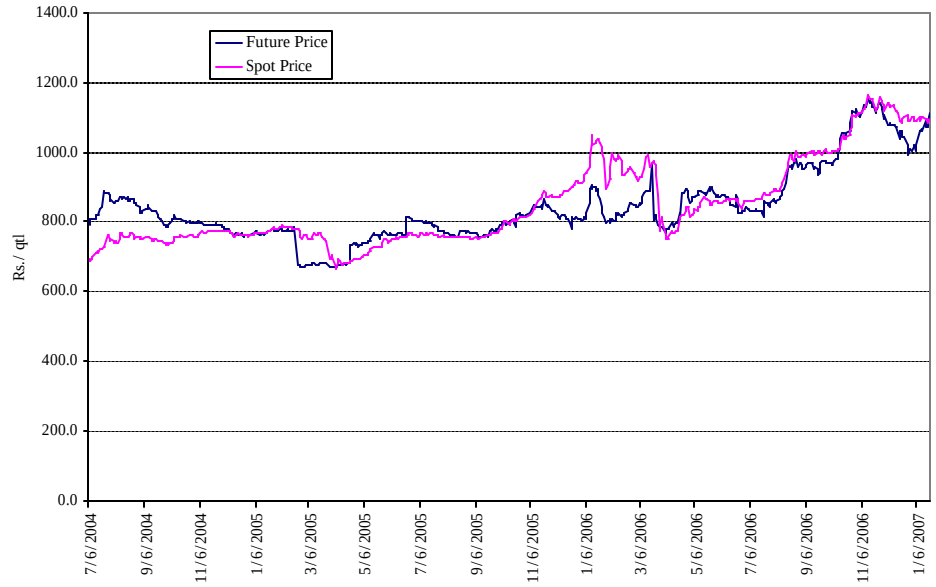

Figure B-2: Trends in future and spot prices of rice

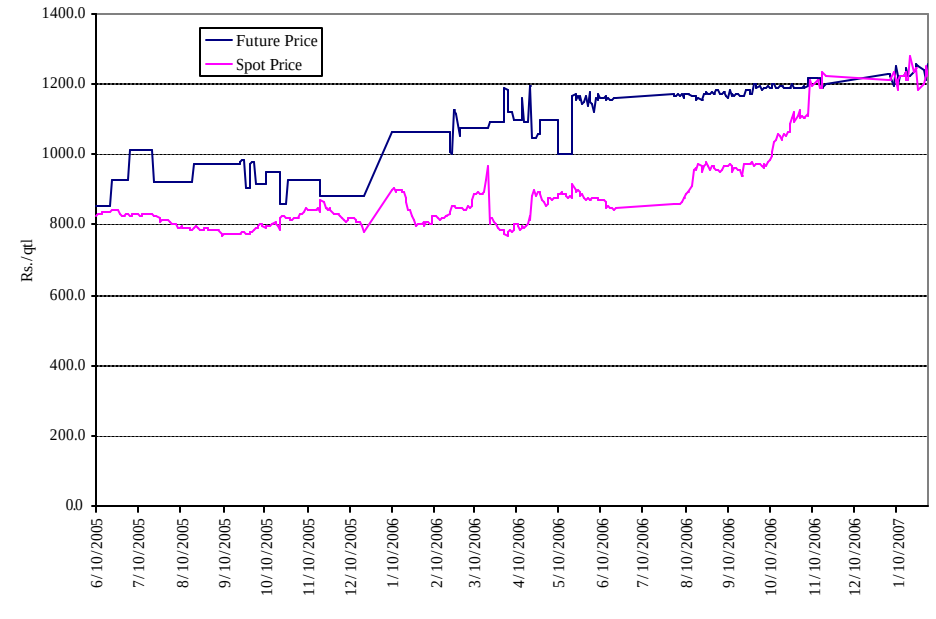

Figure B-3: Trends in future and spot prices of maize

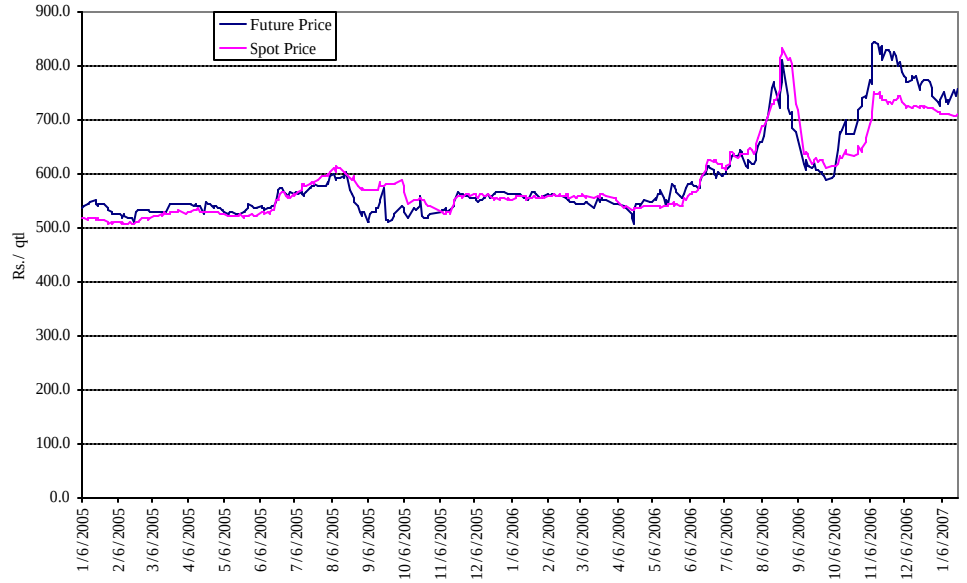

Figure B-4: Trends in future and spot prices of chickpea

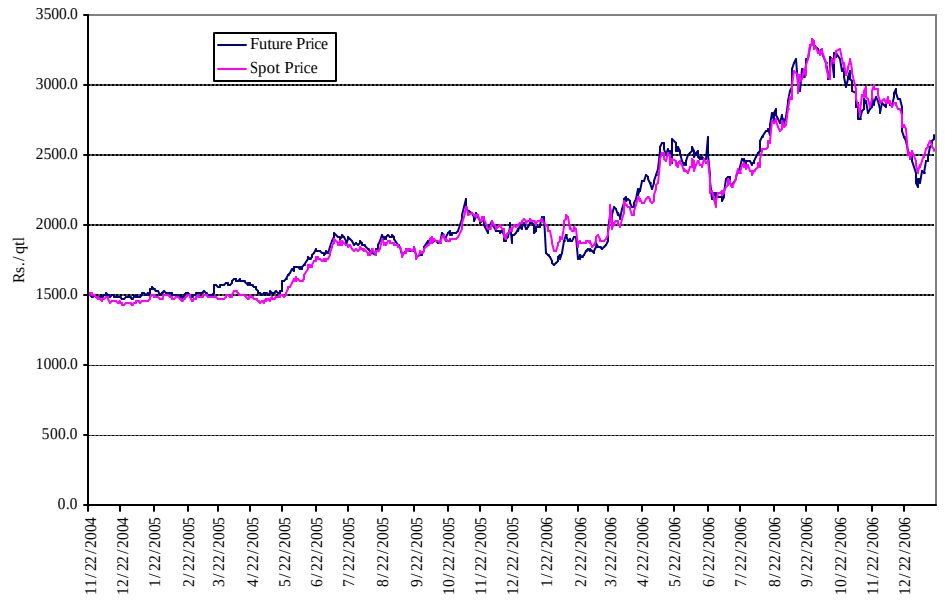

Figure B-5: Trends in future and spot prices of urad

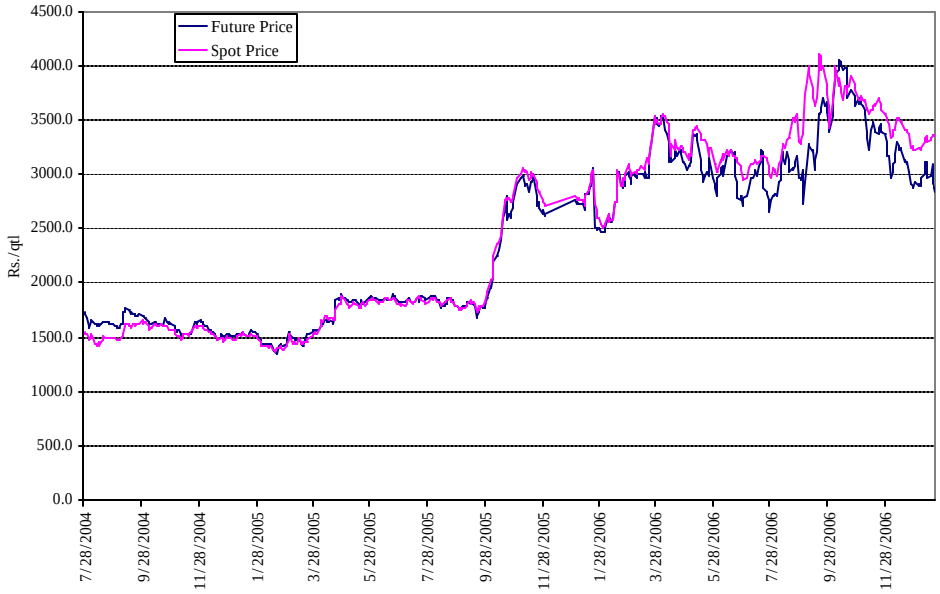

Figure B-6: Trends in future and spot prices of masur

Figure B-7: Trends in future and spot prices of guarseed

Figure B-8: Trends in future and spot prices of pepper

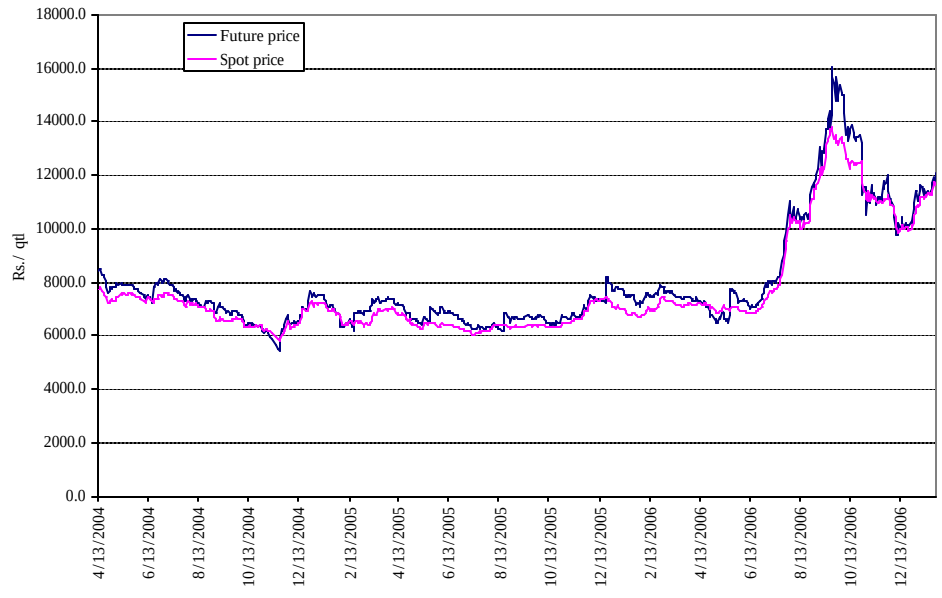

Figure B-9: Trends in future and spot prices of cashew

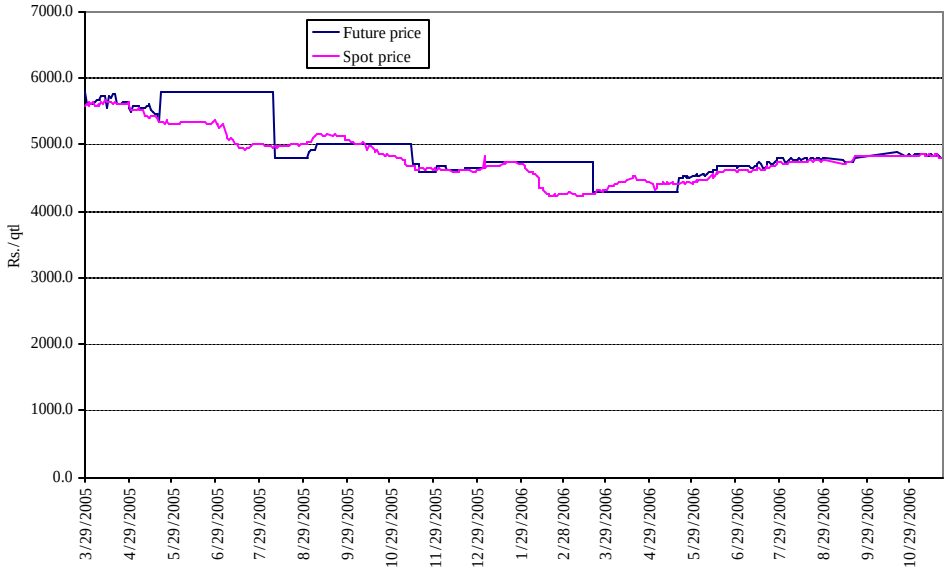

Figure B-10: Trends in future and spot prices of castor seed

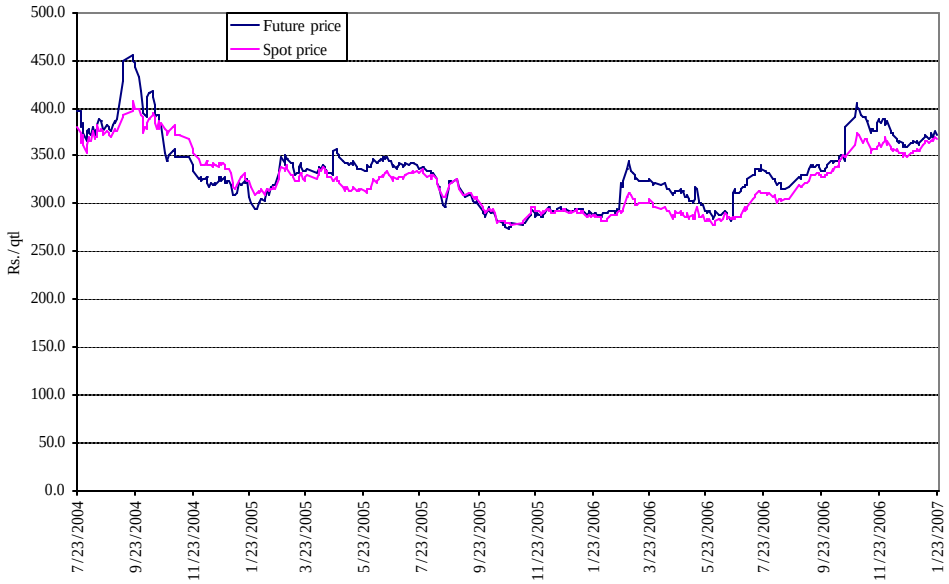

Figure B-11: Trends in future and spot prices of soybean

Figure B-12: Trends in future and spot prices of refined sugar