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RESEARCH ARTICLE :

Market integration of pearl millet in India

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SUMMARY : Dry land agriculture is predominant in many parts of India. In case of millet production, Tamil Nadu stands with total area and production of 6.4 lakh ha and 13.4 lakh tonnes, respectively. The current study seeks to explore the degree of market integration through co-integration analysis on the wholesale monthly prices of pearl millet. Johansen cointegration test used to find out the relationship between various markets in India. Granger causality test is employed to find out the direction of causality between the variables. The overall Granger causality test reveals very significant short-run causal relationships between the selected markets.

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KEY WORDS :
Pearl millet, Dry land agriculture, Market, Granger

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BACKGROUND AND OBJECTIVES

This paper attempted to assess the nature of price movements in Pearl millet. Apart from this, the relationship between various pearl millet markets all over India also studied through market integration. The results will give the overall idea about the prices of pearl millet for all over the country. Millets are three to five times nutritionally superior to the widely promoted rice and wheat in terms of proteins, minerals and vitamins. India ranks 1st in millet production with 1.26 Million tonnes (FAO, 2011). India contributes more than 55 per cent to the global production. Pearl millet accounts for approximately 50 per cent of the total world production of millets. In pearl millet western Indian states playing a major role in (Rajasthan, Gujarat and Haryana) area and production and its accounts for 72 per cent of area and 66 per cent of its production (ICRISAT, 2010). Tamil Nadu stands behind Indian western states with total area and production of 46664 ha and 114447 tonnes, respectively (Season and crop report, 2011-12). Villupuram, Thoothukudi, Cuddalore, Thiruvannamalai, Madurai, Theni and Virudhunagar were the major pearl millet cultivating districts in Tamil Nadu. The price of any agricultural commodity affects positively or negatively affects the farmers in that production of that particular crop. The wide fluctuations in prices of the agricultural commodities are a greatest obstacle. Among millets, pearl millet is one of the important grain.

So, the purpose of the present study is to analyze the current behaviour of pearl millet prices, integration and direction of relationships among various markets.

RESOURCES AND METHODS

The study is based on secondary data. To analyze, the pearl millet prices were collected from various markets of India and Tamil Nadu. Regulated market prices have been taken into consideration for the reason that the wholesale and retail prices may not reflect what the farmers actually receive. Unavailability of some required data is one of the major limitation of this study. The prices data were collected from Agmarknet and DEMIC websites. The markets were selected based on high transaction and handling of pearl millet. The prices were collected for Tamil Nadu (Kovilpatti), Gujarat (Rajkot), Karnataka (Bijapur), Maharastra (Malegon) and Rajasthan (Khairthal) markets. The monthly prices were collected from 2003 to 2015 for all the markets.

Analytical methods :

Cointegration analysis :

The cointegration test was first introduced by Engel and Granger (1987) and then developed and modified by Johansen (1988) and Johansen and Juselius (1990). In 2011, Lahri used Augmented dickey fuller test to determine stationarity and also used Johansen test for coinegration.

- Augmented Dickey-Fuller test
- Johansen test
- Granger Causality test

ADF Test :

Inorder to check the unit roots in the data series, ADF test has been applied. A stationary series is one whose parameters is independent of time constant mean and variance and are having autocorrelations invariant through time.

$$aY_t = {}_1 + ¢\ Y_{t-1} + \sim_i pa\ Y_{t-1} + e_t$$

The number of times (d) a series is differenced to make it stationary is referred to as order of integration I(d). The number of lagged difference terms to be included can be chosen based on t-test, F-test or the Akaike's Information Criterion (AIC). Vector Autoregressive lag selection in gretl software (VAR) was performed to know the AIC criterion.

Johansen cointegration test :

The Johansen approach can determine the number of cointegrated vectors for any given number of non-stationary variables of the same order. This test may be regarded as a long run equilibrium relationship among the markets. The purpose of the cointegration tests is to determine whether a group of non-stationary series is cointegrated or not. In our case, the objective is to determine whether or not the market prices of pearl millet in different markets have a long-run relationship between them.

Granger causality test :

Granger (1969) causality test establishes short-run relationships between stock prices and macroeconomic variables. A Granger causality test is to establish the appropriate direction of the flow of price information. Granger causality test is to assess the direction of causality between the variables.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Cointegration :

In order to check the unit roots in the data series, ADF test has been applied at levels and first difference. Table 1 indicates the results of ADF test, (*i.e.*) stationary level of all non-stationary variables with intercept and no trend. We know that, all non-stationary variables should have the same level of integrating factor for cointegration analysis. From the above results, all variables of this study have the same order, (*i.e.*) I (1).

The results of stationarity tests are given in Table 1.

Table 1 : ADF results

Markets	Level	First difference	Test critical values (1% level)	Conclusion
Gujarat (Rajkot)	-0.39	-9.93		
Karnataka (Bijapur)	-0.39	-12.46		
Tamil Nadu (Kovilpatti)	-0.22	-11.60	3.481	I (1)
Maharastra (Malegon)	-0.34	-10.77		
Rajasthan (Khairthal)	-0.55	-9.95		

The results depicted that the variables involved in this study are integrated of order one, *i.e.*, I(1), therefore the Johansen and Juselius's (1990) cointegration technique has been applied to examine the long-run relationships between the five market prices. In multivariate cointegration analysis using JJ technique, the first step is the appropriate lag selection for the variables.

Akaike information criteria (AIC) and Schwarz Information Criteria (SIC) have been widely used in the time series analysis to determine appreciative length of the distributed lag. Table 2 shows the AIC, BIC and HQC values. This criterion is used to determine the lag length - the smaller the value of the information criteria, the 'better' the model is.

The results of the Johansen and Juselius's Trace test are shown in Table 3. At the 0.05 per cent significance

Table 2 : Vector autoregressive lag selection

Lags	Loglik	P (LR)	AIC	BIC	HQC
1	-692.58		11.00	11.13	11.05
2	-692.53	0.74	11.01	11.17	11.07
3	-684.51	0.00	10.90*	11.08*	10.97*
4	-684.39	0.61	10.91	11.12	11.00
5	-684.11	0.45	10.93	11.15	11.02

* indicates the suitable lag length

Table 3 : Johansen test result

Hypothesized No. of CE (s)	Eigen value	Trace statistic	0.05 Critical value	Probability **
None*	0.283652	112.1897	69.81889	0
At most 1*	0.256942	69.82392	47.85613	0.0001
At most 2*	0.140115	32.10723	29.79707	0.0266
At most 3	0.096693	12.93577	15.49471	0.1172
At most 4	0.000164	0.020846	3.841466	0.8851

Trace test indicates 3 cointegrating equations at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level

Table 4 : Granger causality test

Null Hypothesis	Observations	F statistic	Probability
KA does not Granger Cause GU	130	6.84274	0.0015
GU does not Granger Cause KA		2.52762	0.008
TN does not Granger Cause GU	130	4.42041	0.014
GU does not Granger Cause TN		5.01936	0.008
MH does not Granger Cause GU	130	7.58117	0.0008
GU does not Granger Cause MH		0.70146	0.4978
RJ does not Granger Cause GU	130	19.2243	0.0000
GU does not Granger Cause RJ		6.15826	0.0028
TN does not Granger Cause KA	130	2.34204	0.1003
KA does not Granger Cause TN		9.87762	0.0001
MH does not Granger Cause KA	130	4.90285	0.0089
KA does not Granger Cause MH		4.91494	0.0088
RJ does not Granger Cause KA	130	3.17551	0.0452
KA does not Granger Cause RJ		2.98542	0.0573
MH does not Granger Cause TN	130	8.2561	0.0004
TN does not Granger Cause MH		1.13124	0.3259
RJ does not Granger Cause TN	130	6.54936	0.002
TN does not Granger Cause RJ		1.84283	0.1625
RJ does not Granger Cause MH	130	3.32231	0.0393
MH does not Granger Cause RJ		5.44975	0.0054

TN-Tamil Nadu,KA-Karnataka, GU-Gujarat, MH-Maharashtra, RJ-Rajasthan

level the Trace test suggests that the variables are cointegrated with r ≠ 0. Trace test indicates that there are three cointegration equation.

This study has applied Granger causality test as proposed by Granger (1969) with 2 lag. Granger proposed that if causal relationship exists between variables, they can be used to predict each other. Results from Granger causality test are given in Table 4. The results showed a bi-directional Granger causality between Tamil Nadu and Gujarat, Rajasthan and Gujarat, Maharashtra and Karnataka, Rajasthan and Maharashtra. Unidirectional causal relationship exists between Maharashtra and Gujarat, Tamil Nadu and Karnataka, Tamil Nadu and Maharashtra, Tamil Nadu and Rajasthan. Thus, the overall Granger causality test reveals very significant short-run causal relationships between the selected markets.

This paper determines the market integration among various pearl millet markets. ADF results show all markets prices were become stationary in first difference. Johansen cointegration test confirms the long run relationship between the various pearl millet markets. Granger causality tests reveals very significant short-run causal relationships between the selected markets.

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