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## **Volatile Price and Declining Profitability of Black Pepper in India: Disquieting Future**

**M. Hema, Ranjit Kumar and N.P. Singh\***

### **Abstract**

Historically, black pepper has been a highly tradable commodity; its domestic price, production as well as profitability are highly influenced by its international prices. In 2003-04, the domestic prices of black pepper plunged down to Rs 74/kg from a peak of Rs 215/kg in 1999-2000. The study has therefore been undertaken to identify the drivers for its production, examine the profitability of the farmers and analyse the price behaviour and mechanism of price transmission in black pepper. Like other major spices, the production of black pepper in India has increased substantially over the years. Area under the crop and lagged export quantity have been the main drivers influencing pepper production in the country. From the field survey in two major black pepper growing districts, viz. Idukki and Wayanad, it has been revealed that the production of pepper has become unremunerative due to depressed prices in the domestic and/or global markets coupled with increasing input costs. Further, from the projections for production and demand for black pepper during the period 2005-2015, it is learnt that its production is going to outpace the domestic demand in a big way. This requires a serious attention because until new and diversified export markets are not exploited, the farmers would face further crash in farm gate price due to huge surplus stock. From the co-integration analysis, it has emerged that the three series of prices — farm harvest, domestic, and export, have been moving together over the years and the prices have tended to find equilibrium faster in the long-run than during the pre-liberalization period. The availability of disease-free planting material and financial assistance on easy terms would help the farmers to replace the senile plantation for realizing increased crop yield and profitability. The specific policies for integrating farm harvest price with retail price will not only help the producers but also make these spices somewhat more affordable to the domestic consumers.

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## Introduction

With more than 25 spices commercially grown, India is the largest producer, consumer and exporter of spices in the world. Spices sector is one of the key areas in which India has an inherent strength to dominate the global markets. But, about 90 per cent of spices production in the country is used to meet the domestic demand and only 10 per cent is exported (Peter and Nybe, 2006). Central Statistical Organisation (CSO) has estimated the value of production of all spices to be Rs 142.15 billion during TE 2002-03, which is around 4 per cent to the total value of agricultural output. The contribution of black pepper alone was of Rs 6.36 billion.

Although spices are grown in almost all the states in India, Kerala is the single largest spice-producing state in value terms, next to Andhra Pradesh. In fact, Kerala contributes 97 per cent of the total black pepper production in the country. Black pepper popularly known as ‘King of spices’ or ‘Black gold’, is a perennial vine. Historically, it has been one of the highly tradable commodities; its domestic price, production as well as profitability of the growers are highly influenced by its international price. During recent past, the price of black pepper has nosedived on account of international pressure. The domestic price plunged down to only Rs 74/kg in 2003-04 from a peak of Rs 215/kg in 1999-2000. This has affected the bottom-line of its growers very badly. The study was therefore undertaken to examine the production performance of black pepper, identify the drivers for its production, examine the profitability of farmers in the Kerala state and analyse the price behaviour and mechanism of price transmission in black pepper.

## Data Sources and Methodology

The study was mainly based on the secondary data, but primary data were also collected from the selected black pepper growing farmers to validate the findings from secondary data. Time series data on area, production and prices of black pepper at the state and all-India levels for the period 1970-2002 were obtained from the publication of Spices Board, Ministry of Commerce, Kochi; Directorate of Arecanut and Spices Development, Ministry of Agriculture, Calicut, and Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

Trend analysis was employed to find the probability of occurrence (Harwood *et al.*, 1999) of area, production and yield of black pepper during the 32-year period (1970-2002). The trend analysis was computed using regression Equation (1):

$$Y = a + bT + u_i \quad \dots(1)$$

where,

$Y$  = Area/ Production/ Yield of black pepper

$a$  &  $b$  = Intercept and slope, respectively

$T$  = Time (1, 2, ..., 32 for the years 1970, 1971, ..., 2002)

$u_i$  = Random error-term,  $u_i \sim N(0, \sigma^2)$

The compound growth rates (CGR) of area and yield of the major spices under study were also computed for all-India and two black pepper producing major states, namely Kerala and Karnataka, separately. To understand the extent of instability in area and yield of the selected spices crops, coefficient of variation was computed. The factors influencing production of black pepper were estimated using linear and double log function as per Equation (2):

$$P_t = f(A_t, E_{t-1}, DP_{t-1}, EP_{t-1}, D) \quad \dots(2)$$

where,

$P_t$  = Production in '000 tonnes in the 't<sup>th</sup> year

$A_t$  = Area in '000 ha in the 't<sup>th</sup> year

$E_{t-1}$  = Lagged export quantity in '000 tonnes

$b_t$   $L_t$   $L_{t-1}$   $DP_{t-1}$  = Lagged domestic price in Rs/kg

$EP_{t-1}$  = Lagged export price (FOB) in US\$/kg

$IP_{t-1}$  = Lagged international price in US\$/kg

$D$  = Dummy, 0 for pre-liberalization period (1970-1990) and 1 for post-liberalization period (1991- 2002)

Forecasting techniques were employed for predicting the black pepper production for the period up to 2015, using Holt's exponential smoothing. It is a procedure for continuously revising a forecast that implies exponentially decreasing weights as the observations get older. This method is used when there is a trend in the time series data (Makridakis and Wright, 1998; and Billah *et al.*, 2006). There are two smoothing constants  $\alpha$  and  $\beta$  (with values between 0 and 1) and three equations in this method of forecasting:

$$L_t = L_{t-1} + \alpha (P_{t-1} - L_{t-1}) \quad 0 < \alpha < 1 \quad \dots(3)$$

$$b_t = b_{t-1} + \beta (L_t - L_{t-1}) \quad 0 < \beta < 1 \quad \dots(4)$$

$$F_{t+m} = L_t + b_t m \quad \dots(5)$$

where,

$L_t$  = Estimate of the black pepper production in the 't<sup>th</sup> year

$Y_t$  = Time in years (2005-2015), and

$b_t$  = Estimate of the slope of the series at time 't'.

Equation (5) shows the forecast, for which  $b_t$  was multiplied by the number of periods 'm' ahead to be forecasted, and then added to the base value  $L_t$ . The smoothing parameters  $\alpha$  and  $\beta$  were chosen by minimizing the mean square error (MSE) over observations.

The co-integration technique was employed in the present study to analyze the long-run relationship amongst farm harvest price, domestic price and export price. In the present study, Co-integration test<sup>1</sup> suggested by Engle and Granger (1987) was employed (Gujarati, 2004). In the study, Philip- Perron (PP) unit root test was applied to test the stationarity. It is a non-parametric modification of the Dickey-Fuller test, for controlling higher order serial correlations in a series (Basu and Dinda, 2003).

The test regression for the PP test is the AR (1) process:

$$Y_t = \alpha + \beta Y_{t-1} + \epsilon_t \quad \dots(6)$$

where,

$Y_t$  = Farm harvest/ domestic/ export price

$\alpha$  and  $\beta$  = Parameters, and

$\epsilon_t$  = Random error-term (white noise).

After getting the stationarity in the time series, the next step was to test for co-integration following the Engle-Granger two-step procedure. The first step involved co-integration of two series, which were of the same order of integration.

The co-integration regression model used was:

$$FHP_t = \beta_1 + \beta_2 DP_t + \beta_3 EP_t + u_t \quad \dots(7)$$

where,

$FHP_t$  = Farm harvest price in the 't<sup>th</sup>' year

$DP_t$  = Domestic price in the 't<sup>th</sup>' year

$EP_t$  = Export price in the 't<sup>th</sup>' year

$\beta_1$  = Intercept

$\beta_2$  &  $\beta_3$  = Co-integrating parameters, and

$u_t$  = Co-integration vector / Equilibrium error.

The  $u_t$  residual shows the deviation from equilibrium and this equilibrium error in the long-run tends to zero. This equilibrium error has to be made

stationary for getting co-integration between two integrated variables. The stationarity of the error can be verified through Equation (8):

$$\Delta u_t = a_0 u_{t-1} \quad \dots(8)$$

The test implies that errors adjust to the long-run equilibrium.

In the second step, Error correction model<sup>2</sup> (ECM) developed by Engle and Granger was used for correcting the disequilibrium. The model for ECM was represented as per Equation (9):

$$\Delta FHP_t = \beta_1 + \beta_2 DDP_t + \beta_3 DEP_t + \beta_4 u_{t-1} + \varepsilon_t \quad \dots(9)$$

ECM equation states that  $\Delta FHP_t$  depends on both  $\Delta DP_t$ ,  $\Delta EP_t$  and the equilibrium error-term. If error-term is non-zero, then the model is in disequilibrium. The speed at which the price approaches equilibrium depends on the magnitude of  $\beta_4$ . Hence,  $\beta_4$  is expected to be negative. Then  $\beta_4 u_{t-1}$  is also negative and  $\Delta FHP_t$  will be negative to restore the equilibrium in the long-run.

## Results and Discussion

### Production of Black Pepper

During the past three decades, spices in India have shown tremendous potential. As is evident from Table 1, area under all spices has almost doubled, from 1.32 million hectares in early-1970s to 2.52 million hectares in TE 2002, while their production has almost quadrupled from 0.78 million tonnes in TE-1972 to 2.97 million tonnes in TE-2002. But, the increase in production of black pepper has faltered behind other spices and it has achieved less than triple jump during this period.

To get a clear picture about the nature of growth in area, production and yield of black pepper in India during past three decades, an analysis was carried out to find the probability of occurrence and to know those parameters which were above the trend-value; the results have been presented in Table 2. From this, it was revealed that the overall scenario of spices production in the country was not encouraging. The probability of occurrence of yield of all spices above the trend-line was less than 50 per cent.

The performance of yield of black pepper in Karnataka has been very dismal as the probability of occurrence of being above trend-line was only 18 per cent. It means more than 80 per cent chances were that the yield would perform lower than the trend. Such an analysis is needed because probability of outcome below some critical level gives signal for managing

**Table 1. Trend in area under and production of black pepper vis-à-vis all spices in India**

Crops	TE-1972	TE-1982	TE-1992	TE-2002
<b>Black pepper</b>				
Area ('000 ha)	119.46 (1.8; 97.7)	110.25 (2.5; 97.5)	182.34 (1.6; 94.6)	218.38 (4.1; 93.8)
Production ('000 tonnes)	26.20 (3.9; 95.8)	27.40 (2.6; 97.4)	50.20 (1.5; 97.6)	65.20 (3.2; 95.3)
Yield (kg/ha)	219 (277; 211)	249 (256; 248)	275 (247; 284)	299 (234; 303)
<b>All Spices</b>				
Area ('000 ha)	1315.40	1694.20	2087.10	2518.50
Production ('000 tonnes)	784.70	1296.80	2056.80	2971.80

*Note:* For area and production, first and second figures within parentheses show the share of Karnataka and Kerala in total area and production, respectively. For yield, first and second figures indicate yield (kg/ha) of black pepper in Karnataka and Kerala, respectively.

risk as the producers generally prefer yield and price distributions that are bounded from below to limit their losses.

The empirical results of the production performance in terms of growth rates and coefficient of variations of area and yield of black pepper in two major states are given in Table 3. Black pepper in Karnataka showed a negative growth in area as well as yield during pre-liberalized period while there was a significant area expansion during post-liberalized era, with a

**Table 2. Probability of deviation from trend of area, production and yield of black pepper in India: 1970-2002**

Crops	Area		Production		Yield	
	No. of occurrence above trend line@	PO*	No. of occurrence above trend line@	PO*	No. of occurrence above trend line@	PO*
<b>Black pepper</b>						
Karnataka	16	48.51	12	36.40	6	18.21
Kerala	19	57.62	21	63.62	18	54.60
All India	19	57.58	19	57.58	17	51.50
<b>Total spices</b>						
All India	17	56.67	18	60.00	16	48.50

@Number of years in which the observed area/production/yield was above the respective trend estimates. \*Probability (in %) of area/production/yield above trend-line.

**Table 3. Production performance of black pepper in its major growing states**  
(Per cent)

Crops	Pre-liberalization (1970-1990)				Post-liberalization (1991-2002)			
	Area		Yield		Area		Yield	
	CGR	CV	CGR	CV	CGR	CV	CGR	CV
Karnataka	-0.42	0.15	-1.88	0.24	15.29	0.57	3.15	0.73
Kerala	2.28	0.21	1.39	0.18	1.43	0.06	0.27	0.12
All-India	1.60	0.18	1.20	0.15	1.60	0.07	0.60	0.20

CGR = Compound growth rates and CV= Coefficient of variation

growth rate of 15.29 per cent during second period along with 3.15 per cent growth in yield. As expected, the significant improvement in production performance during second period was dovetailed with increase in instability.

It is clearly evident from Table 3 that the coefficients of variation for both area and yield had increased in the second period compared to those during first period in the Karnataka state. For Kerala, there was a declining growth as well as reduced instability in area and yield for black pepper during post-liberalized period as compared to first period. Since, Kerala alone contributed significantly to the national pool of black pepper, the trend at all-India level was almost similar to that in the Kerala state.

### Drivers of Black Pepper Production

It is a well established fact that the demand of black pepper like other spices is inelastic. Kumar (2005) has estimated expenditure elasticities for spices in 1987 and 1999 by income classes and across different regions in India and has found it to be less than one (0.37-0.60), implying that although the people in India give a considerable importance to spices in their diet, their demand does not increase much as income increases. A very little change in the values of the expenditure elasticity of spices over time was observed. Under such circumstances, the demand for and production of such commodities are to be seen from different perspectives.

To ascertain the drivers of pepper production at the macro level, an empirical analysis was carried out using regression analysis. It is expected that besides farm-level inputs, other external factors also influence the current domestic production such as lagged area, lagged export quantity, lagged domestic price and lagged export price. Linear function gave better results in terms of  $R^2$  as well as number of significant variables (Table 4). In black pepper, area under the crop and lagged export quantity significantly influenced the pepper production positively. Interestingly, domestic price of pepper had



**Table 4. Factors influencing production of black pepper in India**

Variables	Coefficients	
	Linear	Double log
Area ('000ha)	0.28*** (0.07)	1.17*** (0.23)
Lagged export quantity ( '000 tonnes)	0.54* (0.19)	0.24* (0.12)
Lagged domestic price (Rs/kg)	0.03 (0.06)	-0.004 (0.135)
Lagged export price (US\$/kg)	0.20 (2.52)	0.02 (0.19)
Dummy (Pre-liberalization=0 & Post-liberalization=1)	10.85*** (6.12)	0.12 (0.16)
Intercept	-17.04	-2.99
R Square	0.90	0.84

Dependent variable: Production (in '000 tonnes)

Figures within parentheses show standard errors

\*\*\*, \*\* and \* reveal significance at 1, 5 and 10 per cent of probability levels, respectively

been weak, although had positive influence on its production. This may be due to very high fluctuation, in its domestic price. Dummy variable for liberalization period influenced significantly the production of black pepper. Dummy variable revealed that production had undergone sea changes during post-liberalization period as compared to those in earlier period.

#### **Declining Profitability in Pepper Production: Field Level Evidence**

The investigation at the field level on pepper growers revealed that there has been a significant change in its production environment as a result of globalization. The domestic prices are falling continuously over the years on account of illegal imports to India as well as falling international prices. The main pepper belt of Kerala, Wayanad, the district famed for the Malabar pepper among the world's best and most prized varieties are experiencing a panic situation owing to the massive destruction of pepper vines as a result of a disease caused by *Phytophthora capsici* since mid-1990s. The farmers surveyed in Idukki and Wayanad districts expressed that the yield in most of the plantations had reduced to one-third. The farmers in India are hardly able to harvest 282 kg/ha of pepper as compared to other pepper-producing countries like Vietnam or Malaysia, where yield is more than 1500 kg/ha.

Further, frequent droughts and fluctuating temperature adversely affect the yield of this crop. Although it is a rainfed crop, the yield can be increased by about 50 per cent through irrigation in summer. Contrastingly, a majority of spice-growing farmers being small and marginal, making big investment in sprinkler irrigation remains a daunting task for them.

From the field survey in Wayanad and Idukki districts, it was revealed that there existed wide variability in yield realized by the farmers (Table 5). Large farmers, who could afford, were following all the recommended management practices and harvesting as high as 1235 kg/ha yield, while resource-poor farmers could manage only 157 kg/ha yield. Since, a majority of farmers were small and marginal, they were not able to adopt capital-intensive irrigation facilities or other inputs, viz. fertilizers or plant protection chemicals since their profits margins were under pressure due to falling market price of output.

There has been a steady decline in yield and farm gate price of the crop on one hand and a rise in input costs on the other hand. In fact, around 60 per cent of the paid out cost of producing one kg of pepper is attributed towards labour cost only. There was a drastic reduction in farm gate price, from Rs 130/kg in 2000 to Rs 65/kg in 2006. At the same time, the retail market prices are to the tune of Rs 220/kg. All these factors have disturbed the growers in the region as the net profit (considering even only annual maintenance cost, though in plantation crops, there is huge investment cost

**Table 5. Declining yield and profitability in black pepper cultivation in Wayanad and Idukki districts**

Particulars	2000*	2006
1. Labour cost (Rs/ ha)	9060	10899
2. Manure and fertilizers (Rs/ ha)	7020	5788
3. Plant protection measures (Rs/ ha)	3720	5744
4. Harvesting (Rs/ ha)	2626	3159
5. Miscellaneous (Rs/ ha)	1475	1774
6. Annual maintenance cost (Rs/ ha) (1+2+3+4+5)	23901	27364
7. Average yield (kg/ ha)	1064	485
8. Cost of production (Rs/kg)	22.46	56.42
9. Farm harvest price (Rs/kg)	130	65
10. Net profit (Rs/ha)	114419	4161
11. <sup>1</sup> Retail market price in Kerala (Rs/kg)		120.00
12. <sup>1</sup> Retail market price in Delhi (Rs/kg)		220.00

\* The cost for the year 2000 has been taken from M.S. Madan (2000)

<sup>1</sup>Retail market price in Kerala and Delhi is as on 21 June, 2006.

involved) has dropped drastically from about Rs 1.15 lakh to only Rs 4000 per ha.

### Projection for Black Pepper Production

The projection analysis assumes that there would not be any major changes in the Government policy or production environment. Therefore, if everything remains normal, the pepper production will have a growth rate of 1.80 per cent for the next one decade or so (Table 6). Thus, the production of black pepper in India is poised to increase steadily to about 8.44 million tonnes by 2015. Against this, Kumar (2005)<sup>3</sup> has estimated the household consumption demand of black pepper for the years 2005, 2010 and 2015 in India by taking 1999 as the base year. According to this study, domestic demand of black pepper is expected to step up from 0.04 million tonnes in the base year to 0.06 million tonnes by 2015 with a growth rate of 4.14 per cent per annum. The major growth in its demand would come from the lower income groups. These two projected scenarios exhibit a surplus production of black pepper in the country to the tune of about 24 to 32 thousand tonnes in future. To vent out this surplus stock and provide adequate leverage to its growers, the country has to depend on external market, where price and quality play very important role. Against this, India has exported black pepper to the tune of only 22 thousand tonnes in TE 2002-03.

**Table 6. Projected black pepper production in India**

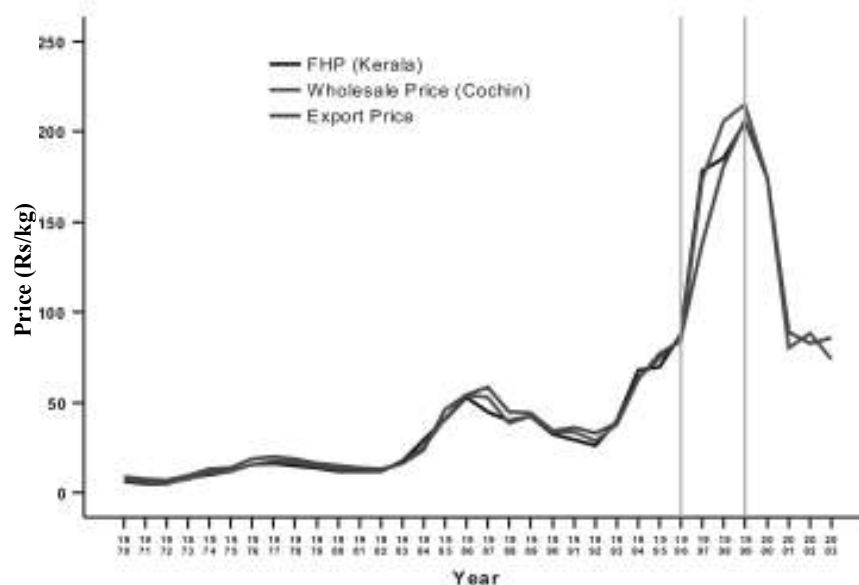
Particulars	TE-2002 <sup>@</sup>	2005	2010	2015	CGR (2005-2015)
Production (‘000 tonnes)	65.24	71.70	78.55	84.41	1.80
Domestic demand* (‘000 tonnes)	40.00	40.00	50.00	60.00	4.14
Surplus production (‘000 tonnes)	25.24	31.70	28.55	24.41	—

\*Projection of domestic demand for black pepper has been taken from Kumar (2005)

<sup>@</sup>Actual production and domestic demand

### Movement of Different Prices of Black Pepper

A majority of the pepper growers in India are small and marginal farmers. For them, a better price is the best incentive to remain in cultivation of this crop and huge volatility, particularly in southward direction discourage them to use better inputs (Fig. 1). The only way to ensure remunerative price to the farmers while maintaining export price at competitive level is to increase the yield of the crop.



\*Farm harvest price for black pepper after 1999-00 is not available

**Fig. 1. Volatility in different prices of black pepper in India**

The supply volatility in the world trade is one of the reasons for price instability and in the case of perennial crop like pepper, farmers do not have time for adjustment, thereby they do not have any other option than to ride the wave of price volatility. This affects badly the bottom line of the small and marginal farmers of this region. It can be seen from the graph (Fig. 1) that although the three prices historically moved together, there has been significant volatility in them during the recent past. This has turned a very profitable crop during late-1990s to almost unremunerative enterprise, keeping rising input (labour) costs in view.

For black pepper, prices have persistently been going down since 2000, as the export of black pepper from India was at peak in the year 1999 and the farmers are finding the crop less and less remunerative year after year, which are bound to affect the farm harvest price of the crop while cost of inputs remains same or increases year after year. While European countries like France, Germany, Italy, Japan, etc. continued to be the major export destinations for Indian pepper, in recent years, Vietnam has emerged as one of the strongest competitor for the Indian pepper in the world market due to its large production base and low domestic consumption, allowing it to offer black pepper at much cheaper rates in the international market. Landing price of Indian pepper is much higher in international market.

### Co-integration Analysis for FHP with Domestic and Export Price

The interdependence among prices is related to their current as well as past levels. Multivariate co-integration technique was employed to study the price interdependence rather than estimating just structural relationship between prices. After having established the requirements of unit root, Engle–Granger co-integration analysis was carried out (Table 7). The farm harvest price in Kerala (since Kerala contributes more than 95% of total production) for black pepper was regressed with domestic wholesale (Cochin) and export price. The  $\tau$ -statistics for pepper revealed that the explanatory variables were highly significant during both the periods, except for export price in the latter period.

**Table 7. Engle-Granger co-integration regressions for black pepper during pre- and post-liberalization periods**

Dependent variable	Explanatory variable	Estimated coefficients	$\tau$ -statistics	F-statistics	D.W.
<b>Pre-Liberalization</b>					
FHP	DP	1.42	5.83***	623.36***	2.13
	EP	-0.44	-1.92**		
<b>Post-Liberalization</b>					
FHP	DP	1.15	4.08***	309.29***	2.58
	EP	-0.24	-0.75		

\*\*\* and \*\* indicate significance at 1 and 5 per cent of probability levels, respectively. Values of t- statistics are 3.06 and 2.18 at 1 and 5 per cent levels of probability, respectively

D.W.C.V. at 5% =0.37, A high Durbin –Watson Critical Value suggests that the residuals of the co-integrating regression are stationary.

To establish that the relationships between FHP, DP and EP are not spurious, the price series has to be verified. Durbin–Watson statistics were used to know the co-integration. Since the D-W statistics of all the regressions are above the critical value at 5 per cent level (0.37), the null hypothesis of no co-integration was not accepted and found that the three series were moving together in a synchronized way. The co-movement of prices of pepper indicated that from one of the price series, other could be predicted. Further, these prices will move together in finding a long-run stable equilibrium relationship.

To test whether these parameters are stationary when moving together, unit root test on the residuals obtained for Engle-Granger was performed (Appendices I & II). Since  $\tau$ -statistics is higher than its table value, it can be concluded that the residuals from the regression of FHP, DP and EP are

stationary. Hence, it was proved that co-integration regression was not spurious, even though individually these price series were non-stationary.

### Price Transmission Mechanism

Long-run equilibrium relationships between these prices were also observed. For this, the error-term can be treated as equilibrium error and also the intertwined relationship in the short-run giving way to a long-run association. The error correction mechanism (ECM) was used to estimate the acceleration speed of the short-run deviation to the long-run equilibrium (Table 8). The advantage of ECM is that it allows for the short-run dynamics as well as an assessment for the degree towards the long-run relation, as shown by co-integration.

**Table 8. Error correction estimate for different prices of black pepper during two periods**

Dependent variable	Explanatory variable	Estimated coefficients	$\tau$ -statistics	F-statistics	D.W.
<b>Pre-Liberalization</b>					
$\Delta$ FHP	$\Delta$ DP	1.64	7.91***	53.52***	1.85
	$\Delta$ EP	-0.62	-3.64***		
	Lagged residual	-1.21	-3.65***		
<b>Post-Liberalization</b>					
$\Delta$ FHP	$\Delta$ DP	1.51	9.94***	69.97***	1.73
	$\Delta$ EP	-0.51	-2.36**		
	Lagged residual	-1.92	-5.26***		

\*\*\* and \*\* reveal significance at 1 and 5 per cent of probability levels, respectively. Values of t- statistics are 3.06 and 2.18 at 1 and 5 per cent levels of probability, respectively.

D.W.C.V. at 5% = 0.37, A high Durbin–Watson Critical Value (DWCV) suggests that the residuals of the co-integrating regression are stationary.

The lagged values and lagged residual of the long-run model and the difference of the farm harvest, domestic and export prices series were used to estimate the error-correction and to determine the short-run deviation from the equilibrium. The coefficients of the error-correction estimate indicated the speed of adjustment at which the price series returns to the equilibrium. All the error-correction coefficients (-1.21 and -1.92) were significant and their signs were negative, which implied that the series converges to the long-run equilibrium for black pepper. It is also evident from the analysis that the absolute value of error-correction term had been higher during post-liberalization period than the first period, indicating that the prices tended to find equilibrium faster in the long-run during this period.

### Conclusions and Policy Implications

Like other major spices, the production of black pepper in India has increased substantially over the years due to its growing importance in both domestic and international markets. However, pepper has very dubious distinction as the yield of this crop has not improved appreciably during the past three decades. While analyzing the determinants of spice production, it has been observed that area under the crop and lagged export quantity have been the main drivers influencing pepper production in the country.

The field survey in two major black pepper growing districts of Western Ghats region, viz. Idukki and Wayanad, has revealed a very scary situation. These districts were once famed in the world market for their pepper quality. But now, the production of this spice has become an unremunerative proposition due to depressed prices in the domestic and/or global markets coupled with increasing input costs. Further, from the projections for the production and demand for the period 2005-2015, it is evident that the pepper production is going to outpace the domestic demand in a big way. This requires a serious attention as until new and diversified export markets are not exploited, the farmers would face further crash in farm gate price due to huge surplus stock.

The integration of markets through co-integration has revealed that the  $\tau$ -statistics for pepper, farm harvest price has been highly integrated with both domestic and export price during both pre- and post-liberalization periods. In other words, the three series of prices have been moving together over the years. The negative coefficients of the error-correction estimates of black pepper have indicated the long-run convergence of all prices to equilibrium, barring some short-run divergences.

Keeping these in view, following policies are suggested for improving the profitability of farmers growing black pepper in the region:

- Most of the pepper plantations are very old, senile and have become uneconomical. The availability of disease-free planting material with lower fruit-bearing age and the financial assistance on easy terms would help the farmers to replant for realizing increased crop yield and profitability. Under such circumstances, the role of Spice Board needs to be widened and more supportive role towards pepper-growing farmers seems to be warranted.
- The specific policies for integrating farm harvest price with retail price will not only help the producers but also make these spices somewhat more affordable to the domestic consumers. The assured price mechanism as extended to other cash crops will fetch a great deal in assuring the economic profit realization by the farmers and will retain their interest, as they are hard hit in the event of any eventuality on the price front.

- The specific focus on quality through adoption of improved cultivars for export and processing perspectives, value-addition in the light of high demand of derived products like oleoresin and spice oil and ensuring quality of international standards of this premium spice in raw as well processed products forms will garner a larger pie in the international export market.

#### Notes

1. The necessary condition for co-integration is the stationarity of time series data. For the stationary time series data, mean value and variance/ co-variance do not vary systematically. To test stationarity, unit root test is employed.
2. Engle and Granger theorem states that if a set of variables are co-integrated of order (1, 1), then there exists a valid error-correction representation of the data. Converse of this theorem also holds good, that is, if an error correction model (ECM) provides an adequate representation of the variables, then they must be co-integrated. Two integrated variables can be co-integrated, when they converge in the long-run, despite short-run divergences. ECM is also known as Granger representation theorem which states that if two variables X and Y are co-integrated, then the relationship between the two can be expressed as ECM.
3. Kumar (2005) has observed that the per capita consumption of black pepper in rural areas has remained 37 grams/year during 1987 and 1999 while in urban areas, it has increased from 58 grams/year to 64 grams/year. Across different income groups in the year 1999-2000, the per capita consumption of pepper was 11, 20, 27 and 55 grams/year for very poor, moderately poor, non-poor low and non-poor high, respectively in rural areas and 22, 33, 44 and 87 gram/year, respectively in urban areas in India.

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### Appendix I

#### Unit root test for different prices of black pepper: Philip- Perron test

Prices	Level		First difference		Second difference	
	Intercept	Intercept & trend	Intercept	Intercept & trend	Intercept	Intercept & trend
Pre-FHP	-1.14	-1.92	-2.44	-2.27	-4.65***	-4.66***
Pre-DP	-1.22	-2.00	-2.59	-2.46	-4.70***	-4.65***
Pre-EP	-1.31	-1.99	-2.61	-2.48	-5.61***	-5.63***
Post-FHP	0.55	-2.29	-3.12*	-3.06	-4.39**	-4.05*
Post-DP	0.58	-2.11	-2.49	-2.07	-3.30*	-3.21
Post-EP	2.34	-1.49	-1.87	-1.98	-2.39	-2.11

\*\*\*, \*\* and \* reveal significance at 1, 5 and 10 per cent of probability levels, respectively; Pre: Pre-liberalized period, Post: Post-liberalized period, DP: Domestic Price, EP: Export Price & IP: International Price

### Appendix II

#### Unit root test on residuals of black pepper

Dependent variable	Explanatory variable	Estimated coefficients	t- statistics	D.W.
<b>Pre-Liberalization</b>				
Δ Resi- FHPDPEP	Lagged residual FHPDPEP	-1.07	-4.66***	2.04
<b>Post-Liberalization</b>				
Δ Resi- FHPDPEP	Lagged residual FHPDPEP	-1.35	-3.92***	2.37

\*\*\* and \*\* reveal significance at 1 and 5 per cent of probability levels, respectively Value of  $\tau$ - statistics is 3.06 and 2.18 at 1 and 5 per cent levels of probability, respectively

D.W.C.V. at 5% =0.37, A high Durbin –Watson Critical Value statistics suggests that the residuals of the co-integrating regression are stationary.

Resi- DPEP: Residuals from regression between domestic price & export price; Resi- DPIP: Residuals from regression between domestic price & international price.