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## **Structural Changes in Horticulture Sector in India: Retrospect and Prospect for XIth Five Year Plan**

**Mahendra Singh and V.C. Mathur\***

I

### INTRODUCTION

The growth of agriculture is not commensurate with other sectors of the Indian economy. The growth in agricultural sector has declined from 3.7 per cent during early reforms period (1991-92 to 1996-97) to 2.5 per cent per annum during Ninth and Tenth Plan (1997-98 to 2006-07) periods, while growth of the gross domestic product (GDP) was observed to be 5.7 and 6.6 per cent per annum during the corresponding period (Government of India, 2008). In agricultural sector, high-value segment is expected to contribute more to the wellbeing of the smallholders, as it requires more labour and generate higher returns than cereals (Joshi *et al.*, 2006). The CGIAR system prioritises high value crops (in particular fruits and vegetables), on the premise that they provide poor farmers the opportunity to derive additional income and increase enterprise stability through crop diversification (CGIAR, 2005). The high value crops (HVCs) generally refer to non-staple horticultural crops which have higher net returns per unit of land than staples. The Working Group on horticulture, plantation crops and organic farming for the XI Five Year Plan (2007-12) redefined horticulture as “science of growing and management of fruits, vegetables including tubers, ornamental, medicinal and aromatic crops, spices, plantation crops their processing, value addition and marketing”.

In 2005-06, horticultural crops contributed around 28 per cent of gross domestic product in agriculture from a mere 13 per cent share of national area under horticultural crops. Vegetables, fruits, plantations crops and spices contributed around 60, 31, 7 and 2 per cent of the total horticultural production respectively in 2006-07. The share of horticulture sector in value of agricultural exports during triennium 2003-05 was about 18 per cent which increased to 37 per cent in 2006-07 (Government of India, 2008). India is one of the largest and lowest cost producers of high value agricultural commodities and yet has a minuscule share in global trade. It produces nearly 11 per cent of all vegetables and 15 per cent of all fruits in the world. The unit value of its export (free on board, FOB) is nearly half the corresponding

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\*Technical Officer and Head, Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi – 110 012.

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world unit values. Yet its share in global exports of vegetables and fruits is only 1.7 and 0.5 per cent, respectively (World Bank, 2007).

On the consumption side, it is observed that the consumption of cereals and pulses has declined, while consumption of HVCs such as livestock products and fruits and vegetables increased substantially during 1993-94 to 2005-06 even among rural consumers in India.

TABLE 1. DECADAL CHANGES IN EXPENDITURE ON FOOD CONSUMPTION OF RURAL CONSUMERS IN INDIA, 1993-94 TO 2005-06

<i>(Rs./month/capita at current price)</i>						
Sl. No.	Item group	50th Round	62nd Round	Share in total food (per cent) 50th Round	Share in total food (per cent) 62nd Round	Change in share in 62nd Round over 50th Round
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Cereals	68.1	106.3	38.3	31.9	-6.4
2.	Pulses and pulses products	10.7	20.02	6.0	6.0	0.0
3.	Milk and milk products	26.7	50.94	15.0	15.3	0.3
4.	Edible oil	12.5	25.46	7.0	7.6	0.6
5.	Egg, fish and meat	9.4	24.31	5.3	7.3	2.0
6.	Vegetables	17	37.88	9.6	11.4	1.8
7.	Fruits and nuts	4.9	11.75	2.8	3.5	0.8
8.	Breweries and others	16	29	9.00	8.7	-0.3
9.	Total food group (Rs.)	177.8	333.15	100.00	100.00	

Source: Household Consumer Expenditure in India, 2005-06, NSS 62nd Round, National Sample Survey Organisation, Ministry of Statistics and Programme Implementation, Government of India, New Delhi, January, 2008.

Note: 50th Round : July 1993 to June 1994; and 62nd Round : July 2005-June 2006.

A comparison of the growth in gross value of output of various sub-sectors of agriculture shows that the growth in fruits and vegetables sector was higher than cereals and highest among all sub-sectors in the year of 2005-06 (Table 2). This may be due to the positive impact of Horticulture Mission.

TABLE 2. GROWTH RATE IN OUTPUT OF VARIOUS SUB-SECTORS OF INDIAN AGRICULTURE, 1951-52 TO 2006-07 (GROSS VALUE OF OUTPUT AT 1999-2000 PRICES)

<i>(per cent)</i>							
Period	Cereals	Pulses and oilseeds	Fruits and vegetables	Other crops	All crops	Livestock	Fishery
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1951-52 to 1967-68	4.19	2.98	2.67	2.42	3	1.02	4.68
1968-69 to 1980-81	3.43	0.97	4.82	2.98	3	3.26	3.08
1981-82 to 1990-91	3.52	5.41	2.84	1.71	2.97	4.78	5.74
1991-92 to 1996-97	2.36	2.92	6.07	2.18	3.09	4.00	7.05
1997-98 to 2006-07	1.39	1.43	3.54	3.70	2.36	3.61	2.93
Ninth Plan	1.49	-1.43	4.11	3.82	2.25	3.53	2.63
Tenth Plan	1.28	4.29	2.97	3.58	2.46	3.69	3.23
2002-03 to 2004-05	-1.27	5.95	0.30	1.57	0.42	3.32	1.77
2005-06 to 2006-07	3.52	1.61	6.97	6.59	5.53	4.23	5.49

Source: Eleventh Five Year Plan (2007-12) Document, Volume-III, Planning Commission, Government of India.

Horticulture was identified by the Government of India in the mid-1980s as a promising emerging sector for agricultural diversification to enhance profitability through efficient land use, optimum utilisation of natural resources and creating employment for rural masses (ICAR, 2005). Consequently Plan investments in horticulture development increased significantly from the Eighth Five Year Plan onwards (Table 3). The allocation for horticulture development during Tenth Plan was Rs. 4,472 crores, which was three times higher than the allocation in Ninth Plan. In addition, Rs. 1,178 crores was allocated to Commodity Boards dealing with plantation crops. During the Tenth Plan, several schemes have been launched in mission mode to promote the horticulture sector in the country, prominently the National Horticulture Mission initiated in 2005-06, covering 340 districts and the Technology Mission for Integrated Development of Horticulture in North Eastern states including Sikkim, Jammu and Kashmir, Himachal Pradesh and Uttarakhand. Under the Horticulture Mission, an area of 2,76,000 hectares have been brought under horticulture crops and 56,000 hectares of old plantations have been rejuvenated (*The Economic Times*, March, 2008). To strengthen their exports, the terminal markets for fruits, vegetables and other perishables in important urban centres provide appropriate infrastructure facilities for electronic auction, cold chain and other logistic support under the umbrella of the Mission. Apart from this, 60 agri-export zones have been established to promote the exports of specific commodities.

TABLE 3. BUDGET ALLOCATION FOR HORTICULTURE DEVELOPMENT IN VARIOUS FIVE YEAR PLANS, INDIA

Sl. No. (1)	Five Year Plan (2)	Budget allocation (Rs. crores) (3)
1.	Fourth	2.1
2.	Fifth	7.6
3.	Sixth	9.1
4.	Seventh	24.2
5.	Eighth	789.0
6.	Ninth	1453.0
7.	Tenth	5650.4

Source: Government of India (2007).

It is well documented that agricultural diversification reduces rural poverty and enhances the sustainability of the agricultural system (Singh, 2001; Kar *et al.*, 2003). The rationale for focusing on diversification towards horticultural crops for triggering agricultural development is on account of its contribution to poverty reduction through higher employment generation, higher potential for value addition and for generating foreign exchange, and provision of food and nutrition security through supply of micro-nutrients and roughages. Given the importance of the horticultural sector in the Indian economy, the present study specifically analyses (1) study the trends and variability in the export of horticultural commodities in India; (2) the trends in area, production and yield of horticultural crops in the country;

(3) the status of diversification towards horticultural crops across states in the country; (4) projects the share of area under horticultural crops in Eleventh Five Year Plan; and (5) based on the findings, to suggest the priority research areas and policy measures to accelerate development of horticulture sector in the country.

## II

### ANALYTICAL FRAMEWORK

The study covered a period of 15 years from 1991-92 to 2005-06. Assuming that the impact of the WTO agreement on multilateral trade would be evident two years after adoption of the provisions by member states in January 1995, the total period was divided into two sub-periods: Period – I: Pre-WTO period from 1991-92 to 1996-97 and Period – II: Post-WTO period from 1997-98 to 2005-06.

#### *Projection of Shares of Horticultural Sub-sectors*

To predict the changes in shares of horticulture sub-sectors, first order finite Markov chain model was used. This model has been used to analyse the structural changes in land holdings, land use, farm and market structure (Prasad *et al.*, 1997, Buckwell and Schucksmith, 1979, Buckwell *et al.*, 1983, Farris and Padberg, 1964, Krenz, 1964, Power and Harris, 1971); forecasting of milk supply, distribution of agricultural firms and crop production (Colman, 1967, Colman and Leech, 1970, Mellor, 1984); identification of stable markets for onion and cashew exports (Murthy and Subrahmanyam, 1999, Ashalatha, 2004, and Mahadevaiah *et al.*, 2005). The first order finite Markov chain model is a stochastic process which has specific features such as the finite number of possible states, the random nature of the process, the condition that the outcome this period is affected only by the previous period's outcome and the stationary condition. The model can be expressed algebraically as follows:

$$E_{jt} = \sum_{i=1}^r E_{it-1} P_{ij} + e_{jt} \quad \dots(1)$$

where,

- $E_{jt}$  = Area (per cent) in the  $i$ -th horticulture sub-sector during the year  $t$ ;
- $E_{it-1}$  = area under  $i$ -th horticulture sub-sector during the year  $t-1$ ;
- $P_{ij}$  = Probability that area will shift from the  $i$ -th horticulture sub-sector to  $j$ -th horticulture sub-sector;
- $e_{jt}$  = Error term which is statistically independent of  $e_{jt-1}$ ; and
- $r$  = Number of sub-sectors.

The estimated share of horticulture sub-sector during the period  $t$  was obtained by multiplying the value of area (per cent of total area under field and horticulture crops) during the previous period ( $t-1$ ) with the estimated transitional probability matrix. The transitional probability matrix was estimated in the linear programming framework by applying mean absolute deviation method in which objective function is to minimise the sum of absolute errors, subject to the constraints of the equation, the row sum condition and the non-negativity condition as follows:

$$\text{Min } O P^* + I_e \text{ (sum of the absolute errors)}$$

Subject to,

$$X P^* + U = \text{(matrix from the equation),}$$

$$G P^* = 1 \text{ (row sum condition),}$$

$$P^* \geq 0 \text{ (non-negativity condition),}$$

Where,

$O$  is a null vector;

$P^*$  is the vector in which the probabilities  $P_{ij}$  are arranged in one column;

$I$  is an appropriate dimensional column vector of units;

$e$  is the vector of absolute errors;

$X$  is the block diagonal matrix of lagged values of  $Y$ ;

$U$  is the vector of errors; and

$G$  is a grouping matrix to add the row elements of  $P$  as arranged in  $P^*$ .

To test whether the observed shares of the area under various sub-sectors and the estimated shares from the Markov chain model follow similar distributions, the modified chi-square test has been applied to the data for each importing country (Kendall and Stuart, 1961).

$$\chi^2_{(r-1)T} = \sum_t^T \sum_i^r N(t) \{Y_i(t) - y_i(t)\}^2 / y_i(t) \quad \dots(2)$$

Where,

$Y_i(t)$  is observed proportion of the  $i$ -th horticulture sub-sector's share at time  $t$ ;

$y_i(t)$  is the estimated proportion of  $i$ -th horticulture sub-sector's share at time  $t$ ;

$N(t)$  is sum of sub-sector at time  $t$ ; and

$T$  is year.

To compare the calculated value of  $\chi^2$  with the table value we have to determine the appropriate degree of freedom. In the contingency table degrees of freedom has been calculated as follows:

Degrees of freedom (v) = (c-1) (r-1)

Where, c is number of columns and r refers to number of rows in the table.

#### *Estimation of the Degree of Diversification*

The Herfindahl index was used to measure the degree of diversification on the basis of area under various crops in the agricultural systems at a point of time in a particular region. The index was computed by taking sum of squares of proportion of value of each crop in the system; mathematically it is expressed as follows:

$$HI = \sum_{i=1}^n P_i^2 \quad i= 1,2,\dots,n. \quad \dots(3)$$

Where,

$P_i$  is the proportion of area under i-th crop in the total system;  
n is the number of crops in the system.

The value of the Herfindahl index ranges between 0 to 1, where 0 indicates perfect diversification and 1 refers to perfect specialisation; thus the index bears inverse relationship with diversification.

### III

#### RESULTS

High value crops (HVCs) account for a major share of total agricultural exports. In TE 2005-06, HVCs contribution in total agricultural exports was 44 per cent and nearly half of this came from the exports of horticultural commodities (Table 4). Among the horticultural commodities, cashew ranked first followed by spices, fresh fruits and fresh vegetables, respectively, in export values during the period TE 2001-02 to TE 2005-06. In terms of temporal changes, the maximum increase in triennium ending (TE) 2005-06 over TE 2001-02 was observed in value of exports of fresh fruits followed by floriculture products.

In relative terms substantially higher growth was observed in exports of horticultural commodities in comparison to total cereals and agricultural products (Table 5). Total floriculture and fruit seeds ranked first in export growth followed by growth in total fruits and vegetables exports. However, variability in the export of horticultural commodities was also high implying less stability in horticulture export compared to cereals. Higher variability in exports may be due to inadequate vertical and horizontal integration in supply chain and each of export markets for horticultural products.

TABLE 4. CHANGES IN INDIA'S EXPORTS OF MAJOR HORTICULTURAL COMMODITIES, 2001-02 TO 2005-06

Commodity/Period (1)	Value (US\$ million)		Per cent share in agri-exports TE 2005-06 (4)	Per cent share in total merchandise exports TE 2005-06 (5)	Per cent change in TE 2005-06 over TE 2001-02 (6)
	TE 2001-02 (2)	TE 2005-06 (3)			
Floriculture products	27	59	0.6	0.06	119
Spices	359	419	4.8	0.51	17
Cashew	464	500	5.7	0.6	8
Fruits/vegetables seeds	15	16	0.2	0.02	7
Fresh fruits	81	204	2.3	0.25	152
Fresh vegetables	100	202	2.3	0.25	102
Processed vegetables	45	84	0.9	0.1	87
Processed fruits and juices	105	98	1.1	0.12	-7
Horticultural commodities	1196	1582	17.9	1.91	32
Dairy products	27	105	1	0.12	289
Miscellaneous processed items	112	218	2.5	0.27	95
Meat and preparations	254	465	5.3	0.56	83
Poultry products	23	64	0.7	0.08	178
Marine products	1274	1401	16.2	1.73	10
High value commodities	2886	3832	44	5	33
Agricultural and allied products	5839	8736	100	10.62	50

*Source:* Author's calculations with data from Foreign Trade and Balance of Payments, Centre for Monitoring Economy, Mumbai (various issues).

TABLE 5. GROWTH AND VARIABILITY IN EXPORT VALUES OF INDIAN HORTICULTURAL PRODUCTS, 1995-96 TO 2006-07

Item (1)	Compound growth (per cent/annum) (2)	Variability (per cent) (3)
Floriculture	20.4	89
Fruits and vegetables seeds	6.7	33
Total for floriculture and seeds	16.2	71
Fresh onions	16.5	69
Other fresh vegetables	16.3	53
Dried nuts (walnuts)	5.4	25
Fresh mangoes	10.1	36
Fresh grapes	16.2	74
Other fresh fruits	14.7	49
Total for fruits and vegetables	14.5	55
Dried and preserved vegetables	0.3	41
Mango pulp	15.5	51
Pickle and chutney	15.1	58
Other processed fruits and vegetables	17.2	62
Total processed fruits and vegetables	15.2	55
Total animal products	17.6	63
Total other processed foods	8.2	37
Total cereals	7.5	36
Agricultural products	10.3	40

*Source:* Author's calculations with data from Government of India (2008), APEDA, 2008.



The growth and variability of area, production and yield of major horticultural sub-sectors are presented in Table 6. Substantial growth has occurred in area of all the sub-sectors during the entire period (1991-92 to 2005-06) but maximum growth was observed in case of spices, followed by fruits, plantation crops and vegetables respectively. However, variability also moved in the same direction, indicating the unstable nature of area expansion on account of price volatility. Area growth was the highest for plantation crops and lowest for vegetable crops during pre-WTO period (1991-92 to 1996-97), while variability also followed the same trends. During post-WTO period (1997-98 to 2005-06) highest growth in area was observed for fruits crop followed by spices. The trend in variability also followed the same direction, indicating that area expansion encourages variability. A negative yield growth in fruit crops coupled with positive production growth during post-WTO period implies that the total gain in production has come from area expansion.

TABLE 6. GROWTH AND VARIABILITY OF MAJOR HORTICULTURAL SUB-SECTORS IN INDIA, 1991-92 TO 2005-06

Crop/sector (1)	<i>(per cent)</i>								
	Area			Production			Yield		
	Entire period (2)	Pre- WTO period (3)	Post- WTO period (4)	Entire period (5)	Pre- WTO period (6)	Post- WTO period (7)	Entire period (8)	Pre- WTO period (9)	Post- WTO period (10)
	Compound growth								
Fruits	3.83	3.65	4.95	3.48	7.27	2.89	-0.34	3.49	-1.96
Vegetables	2.27	0.36	2.49	4.04	4.71	3.40	1.73	4.34	0.89
Plantation	2.30	4.50	1.79	2.07	5.36	1.81	-0.23	0.83	0.01
Spices	3.90	1.73	4.87	6.28	6.14	7.70	2.29	4.33	2.69
Total	3.16	2.24	3.74	3.82	5.66	3.27	0.65	3.34	-0.45
	Variability								
Fruits	18.98	7.14	15.84	16.54	13.41	11.05	7.60	8.40	7.48
Vegetables	11.09	5.61	7.48	18.32	8.69	11.18	9.18	9.46	5.05
Plantation	10.39	8.39	5.39	13.35	10.23	12.40	8.42	5.37	10.23
Spices	27.76	7.10	27.42	30.18	12.43	23.44	16.96	8.30	17.87
Total	14.73	4.59	10.98	17.16	10.28	10.47	6.82	6.96	6.15

Source: National Horticulture Board (2007), Indian Horticulture Database, Ministry of Agriculture, Government of India, New Delhi.

An analysis of the growth and variability in area, production and yield of major horticultural crops showed that citrus, brinjal and cashewnut had the highest growth in area among fruits, vegetables and plantation crops sectors, respectively (Table 7). High growth in production, accompanied by high variability was observed in guava, brinjal and cashewnut among fruits, vegetables and plantation crops, respectively. In fruits, vegetables and plantation crops, highest growth in yield was seen in pineapple, cauliflower and arecanut respectively, respectively while mango, tomato and arecanut

TABLE 7. GROWTH AND VARIABILITY IN AREA, PRODUCTION AND YIELD OF MAJOR HORTICULTURAL CROPS IN INDIA, 1991-92 TO 2005-06

Crop (1)	<i>(per cent)</i>																	
	Growth									Variability								
	Entire period			Pre-WTO period			Post-WTO period			Entire period			Pre-WTO period			Post-WTO period		
Area (2)	Produ- ction (3)	Yield (4)	Area (5)	Produ- ction (6)	Yield (7)	Area (8)	Produ- ction (9)	Yield (10)	Area (11)	Produ- ction (12)	Yield (13)	Area (14)	Produ- ction (15)	Yield (16)	Area (17)	Produ- ction (18)	Yield (19)	
Apple	0.9	2.2	1.3	3.2	2.0	-1.2	-0.7	4.6	5.3	8.3	15.7	6.0	5.6	4.8	7.7	17.6	20.2	
Banana	2.2	3.8	1.6	2.3	9.3	6.8	2.3	1.9	-0.4	10.4	19.1	11.2	5.6	18.0	13.5	7.7	12.2	
Citrus	4.7	5.2	0.5	4.9	8.8	3.8	6.0	5.1	-0.8	22.1	22.9	8.0	9.5	16.9	8.7	17.3	14.8	
Guava	4.4	7.3	2.7	4.7	7.0	2.2	6.1	6.7	0.5	21.0	32.4	15.7	11.5	26.6	19.2	16.8	18.9	
Litchi	3.6	3.2	-0.3	8.7	7.9	-0.7	1.9	0.9	-1.1	16.1	15.0	4.5	15.7	14.1	3.7	6.7	4.7	
Mango	1.0	3.2	2.2	-0.2	9.7	10.0	0.8	-1.4	-2.1	7.0	18.8	18.8	6.2	17.2	19.1	5.6	10.7	
Papaya	4.4	1.8	-2.4	4.3	3.6	-0.7	5.3	3.0	-2.1	20.1	10.8	13.0	8.0	8.9	6.1	14.9	10.4	
Pineapple	2.6	7.5	4.7	7.4	12.1	4.3	0.5	5.2	4.7	14.1	33.4	22.6	13.7	23.3	12.0	8.1	20.4	
Sapota	2.7	3.2	0.5	4.5	4.8	0.3	2.2	4.3	2.0	11.9	15.3	6.8	8.6	12.6	7.9	6.2	11.9	
Brinjal	11.8	7.1	-4.2	12.1	8.6	-3.1	15.2	8.0	-6.3	56.2	33.1	20.2	21.7	15.6	6.9	43.0	24.6	
Cabbage	3.1	4.0	0.9	9.0	10.0	1.0	2.4	2.7	0.3	14.2	17.3	4.7	16.5	18.0	4.4	7.0	8.0	
Cauliflower	2.6	5.4	2.8	3.5	5.7	2.1	1.9	0.9	-0.9	12.6	24.0	14.7	9.8	12.3	6.2	7.3	4.6	
Okra	2.2	4.4	2.2	2.0	-1.0	-3.0	1.0	1.0	0.0	11.2	21.7	13.2	8.0	13.2	11.1	6.1	5.5	
Onion	1.6	2.1	0.6	10.0	11.5	1.4	1.5	1.3	-0.3	14.7	15.8	5.0	23.9	25.9	6.1	5.2	4.8	
Peas	4.3	3.8	-0.5	3.5	-4.4	-7.7	6.5	10.1	3.4	22.8	30.7	14.9	7.1	15.0	18.0	20.8	32.9	
Tomato	4.0	3.4	-0.6	7.1	21.5	13.4	0.9	-3.7	-4.6	18.6	25.6	20.3	14.1	34.1	25.2	6.2	16.8	
Potato	4.2	5.5	1.2	5.8	6.4	0.5	2.5	3.5	1.0	18.2	24.2	7.0	10.9	11.4	2.3	7.4	12.0	
Sweet potato	2.3	3.8	1.4	0.5	4.3	3.9	3.1	5.1	2.0	12.3	18.9	9.0	7.5	13.5	9.0	9.8	15.1	
Tapioca	-0.7	-0.2	0.5	-0.7	-1.1	-0.3	1.2	1.5	0.3	7.3	5.8	3.1	3.9	4.1	2.7	6.6	6.3	
Areca nut	-0.3	1.6	1.9	-0.1	-0.5	-0.3	-0.7	2.0	2.7	6.5	12.1	10.1	4.7	4.3	4.8	7.7	12.4	
Cashewnut	4.1	4.7	0.6	3.5	4.4	0.9	4.8	5.7	0.9	18.4	21.7	3.8	6.5	8.1	2.0	13.2	16.1	
Coconut	3.2	4.2	1.0	4.2	6.4	2.1	2.7	4.2	1.4	14.0	19.6	8.8	8.2	14.1	6.7	7.8	13.6	

Source: National Horticulture Board (2007), Indian Horticulture Database, Ministry of Agriculture, Government of India.

showed maximum variability during the entire period. This implies that the growth in area and production is positively correlated with variability of the crop during entire period. During the pre-WTO period litchi, brinjal and coconut in area; mango, tomato and coconut in production and yield ranked first in growth among the three crop groups or sectors. The maximum variability was observed in mango, tomato and coconut, which implies that production and yield of horticultural crops are positively correlated with variability during the pre-WTO period. Guava, brinjal and cashewnut in area; guava, peas and cashewnut in production; and apple, peas and cashewnut in yield showed highest growth during the post-WTO period. During both sub-periods brinjal and cashewnut showed continuous production growth among vegetables and plantation crops with maximum variability.

Temporal changes in area, production and yield of major fruits crops in major growing states of the country are presented in Table 8. The maximum positive shift in area, production and yield of fruit crops was seen in the states of Maharashtra, Manipur and Rajasthan, respectively. A positive change in production is evident in all the states in 2005-06 over 1991-92. However, this positive change in production is mainly the result of area expansion rather than yield enhancement, as indicated by the proportion of the changes over time, in most states with the reverse being the case in some states. This is not conducive to the development of fruits sub-sector. There is a need to identify the factors responsible for the small increases, and even a decline in some states, in yield of fruit crops in the study period.

A mixed trend was seen in the case of vegetables during the period 1991-92 to 2005-06 in the major growing states in the country. The positive shift in production of vegetables over the period was more on account of the increase in yield in several states and an expansion in area in a few states (Table 9). At the national level, the increase in production is mainly contributed by yield enhancement.

The changes in area and production of flowers in major growing states in 2005-06 over 1993-94 are presented in Table 10, which indicate that the states of Karnataka, West Bengal and Andhra Pradesh occupied the top three positions with respect to area under flowers during both periods. The positive changes in area under flowers are reported in all states and maximum change in area was observed in Himachal Pradesh, Manipur and Delhi states. Production of flowers also shows a substantial increase in the latter period over the former period.

TABLE 8. CHANGES IN AREA, PRODUCTION AND YIELD OF FRUIT CROPS IN MAJOR GROWING STATES OF INDIA, 1991-92 TO 2005-06

State (1)	Area (000 ha)		Production (000 tonnes)		Yield (t/ha)		Change in 2005-06 over 1991-92 (per cent)		
	1991-92 (2)	2005-06 (3)	1991-92 (4)	2005-06 (5)	1991-92 (6)	2005-06 (7)	Area (8)	Production (9)	Yield (10)
Andhra Pradesh	313	783	4008	8696	13	11	150	117	-13
Arunachal Pradesh	20	52	47	105	2	2	156	122	-13
Assam	72	113	886	1352	12	12	56	53	-2
Bihar	267	310	2799	3474	10	11	16	24	7
Goa	11	10	84	184	8	18	-5	118	131
Gujarat	85	270	1829	4678	22	17	219	156	-20
Haryana	14	27	110	236	8	9	94	115	11
Himachal Pradesh	157	183	340	692	2	4	16	104	75
Jammu and Kashmir	119	163	701	1289	6	8	37	84	34
Karnataka	209	263	3192	4242	15	16	26	33	6
Kerala	236	342	1101	2793	5	8	45	154	75
Madhya Pradesh	65	114	1245	1775	19	16	76	43	-19
Maharashtra	256	1370	3518	10252	14	7	435	191	-46
Manipur	20	31	43	189	2	6	57	340	179
Meghalaya	24	28	218	232	9	8	17	6	-9
Orissa	136	238	978	1403	7	6	74	43	-18
Punjab	73	52	664	746	9	14	-29	12	58
Rajasthan	23	25	114	419	5	17	9	268	239
Tamil Nadu	136	258	2316	5779	17	22	89	149	32
Tripura	45	33	319	525	7	16	-27	65	124
Uttar Pradesh	453	445	2879	3813	6	9	-2	32	35
West Bengal	111	173	1132	2302	10	13	55	103	31
Others	28	43	109	180	4	4	51	65	9
All India	2875	5324	28632	55356	10	10	85	93	4

Source: Author's calculations with data from Government of India (2007), Indian Horticulture Database, National Horticulture Board, Ministry of Agriculture, New Delhi. <http://mhb.gov.in/2005-06>. Accessed 25th August, 2008.

TABLE 9. CHANGES IN AREA, PRODUCTION AND YIELD OF VEGETABLE CROPS IN MAJOR GROWING STATES OF INDIA, 1991-92 TO 2005-06

State (1)	Area (000' ha)		Production (000' tones)		Yield (t/ha)		Change in 2005-06 over 1991-92 (per cent)		
	1991-92 (2)	2005-06 (3)	1991-92 (4)	2005-06 (5)	1991-92 (6)	2005-06 (7)	Area (8)	Production (9)	Yield (10)
Andhra Pradesh	155	267	1453	4374	9	16	72	201	75
Arunachal Pradesh	17	20	80	81	5	4	18	2	-14
Assam	222	319	2132	4229	10	13	43	98	38
Bihar	843	1029	8643	16758	10	16	22	94	59
Delhi	55	40	628	672	11	17	-28	7	48
Gujarat	115	380	1668	6308	15	17	232	278	14
Haryana	61	233	877	2985	14	13	283	240	-11
Himachal Pradesh	39	63	476	1062	12	17	62	123	38
Jammu and Kashmir	180	55	745	1053	4	19	-70	41	364
Karnataka	351	382	3673	4579	10	12	9	25	15
Kerala	202	165	3229	3546	16	22	-19	10	35
Madhya Pradesh	176	392	2221	5228	13	13	122	135	6
Maharashtra	241	399	4171	4740	17	12	65	14	-31
Manipur	12	8	50	67	4	8	-29	33	88
Meghalaya	26	42	219	340	8	8	61	55	-4
Orissa	710	657	7275	8053	10	12	-8	11	20
Punjab	85	152	1450	2435	17	16	80	68	-7
Rajasthan	63	121	307	741	5	6	92	141	26
Tamil Nadu	889	234	3797	6547	4	28	-74	72	555
Tripura	30	33	307	374	10	11	8	22	13
Uttar Pradesh	634	968	10245	18147	16	19	53	77	16
West Bengal	456	1210	4680	18663	10	15	165	299	50
Others	30	46	206	417	7	9	54	103	31
All India	5593	7213	58532	111399	10	15	29	90	48

Source: Author's calculations with data from Government of India (2007), Indian Horticulture Database, National Horticulture Board, Ministry of Agriculture, New Delhi. <http://nhb.gov.in/2005-06>. Accessed 25th August, 2008.

TABLE 10. CHANGES IN AREA AND PRODUCTION OF FLOWERS IN MAJOR GROWING STATES OF INDIA, 1993-94 TO 2005-06

State (1)	Area (ha)		Production Loose (MT)		Production (lakh numbers) Cut		Change (per cent)		
	1993-94 (2)	2005-06 (3)	1993-94 (4)	2005-06 (5)	1993-94 (6)	2005-06 (7)	Area (8)	Loose (9)	Cut (10)
Karnataka	15243	21060	87999	156257	-	5239	38	78	-
West Bengal	12610	17886	9020	42292	4790	9348	42	369	95
Andhra Pradesh	5778	16083	17334	79788	-	89	178	360	-
Maharashtra	2275	9250	18188	56078	-	-	307	208	-
Uttar Pradesh	-	8250	-	12180	-	3668	-	-	-
Rajasthan	1207	3008	-	2255	-	-	149	-	-
Haryana	1200	5418	22400	26320	327	623	352	18	91
Madhya Pradesh	915	1869	900	1122	-	-	104	25	-
Delhi	801	5538	4056	5666	-	1038	591	40	-
Punjab	332	800	549	4100	-	-	141	647	-
Assam	280	987	37	-	-	-	253	-	-
Orissa	100	592	460	19275	4	130	492	4090	3150
Jammu and Kashmir	-	226	-	922	-	110	-	-	-
Bihar	85	190	1430	2303	2	11	124	61	450
Manipur	56	535	23	701	-	-	855	2948	-
Himachal Pradesh	30	400	110	3010	429	434	1233	2636	1
India	40969	126235	224437	693401	5552	27618		209	209

Source: Author's calculations with data from Government of India (2007).

The changes in the degree of Herfindahl index on the basis of area under crops grown during 2005-06 over 1992-93 in the country is presented in Table 11. The maximum change was observed in horticultural crops indicating that the degree of agricultural diversification would increase through inclusion of horticultural crops in the cropping pattern.

TABLE 11. CHANGES IN DEGREE OF AGRICULTURAL DIVERSIFICATION INDEX IN INDIA, 1992-93 TO 2005-06

Crop (1)	TE (1992-1993)	TE (2005-06)	Percentage change	Diversification intensity (5)
	Herfindahl index (2)	Herfindahl index (3)	in 2005-06 over 1992-93 (4)	
Field (19) crops	0.1171	0.1153	-1.61	Increased
Horticultural (23) crops	0.0997	0.0926	-7.11	Increased
Field+Horticultural (42) crops	0.1080	0.1023	-5.36	Increased
Horticultural sub-groups (fruit+vegetables+flowers+pla ntation+nuts+spices)	0.2833	0.2651	-6.42	Increased

Sources: a) National Horticulture Board (2007), Indian Horticulture Database, Ministry of Agriculture, Government of India, New Delhi.

b) *Agricultural Statistics at a Glance*, Ministry of Agriculture, Government of India, New Delhi (various issues).

The status of diversification in major horticultural crops growing states in the year 2005-06 are presented in Table 12. Tripura, Daman and Diu, West Bengal,

Assam and Madhya Pradesh had lowest indices in the individual horticultural sub-groups, namely, fruits, vegetables, plantation, spices and also for overall groups respectively. This implies that these states are ranked first with respect to diversification among all states as the value of Herfindahl index and diversification have an inverse relationship. The state of Madhya Pradesh ranked first, followed by Chandigarh and Kerala among all states in terms of diversification on the basis of all horticultural crops grown in the states.

TABLE 12. STATUS OF THE HORTICULTURAL DIVERSIFICATION IN INDIAN STATES, 2005-06

State/UT (1)	Fruits (2)	Vegetables (3)	Plantation (4)	Spices (5)	Total horticultural crops (11 each from fruits, vegetables, spices+4 plantation crops) (6)	Overall horticultural groups (fruits+ vegetables+ flowers+nuts+ aromatic+plant- ation+spices) (7)	Ranks based on total horti- cultural crops (8)
Andaman Nicobar	0.377	0.772	0.750	0.266	0.468	0.305	4
Andhra Pradesh	0.412	0.197	0.487	0.455	0.131	0.466	13
Arunachal Pradesh	0.286	0.673		0.511	0.170	0.595	30
Assam	0.223	0.576	0.518	0.222	0.185	0.375	11
Bihar	0.287	0.225		0.228	0.138	0.544	22
Chandigarh	1.000	1.000			0.500	0.269	2
Chhattisgarh	0.314	0.211		0.340	0.122	0.828	35
D & N Haveli	1.000	1.000			0.566	0.560	25
Daman and Diu	0.336	0.116			0.098	0.315	6
Delhi	0.341	0.480			0.479	0.342	7
Goa	0.336	1.000	0.547		0.374	0.772	34
Gujarat	0.218	0.162	0.685	0.472	0.101	0.594	29
Haryana	0.253	0.262			0.213	0.543	21
Himachal Pradesh	0.312	0.230		0.281	0.194	0.519	17
Jammu & Kashmir	0.453	0.242		0.488	0.259	0.576	27
Jharkhand	0.228	0.000			0.228	0.362	9
Karnataka	0.286	0.245	0.471	0.278	0.135	0.520	18
Kerala	0.313	0.684	0.685	0.565	0.267	0.290	3
Lakshdweep	0.333	1.000	1.000		0.719	0.566	26
Madhya Pradesh	0.264	0.147		0.385	0.107	0.249	1
Maharashtra	0.224	0.229	0.800	0.765	0.116	0.445	12
Manipur	0.363	0.215		0.587	0.176	0.518	16
Meghalaya	0.260	0.331	0.541	0.415	0.116	0.735	33
Mizoram	0.310	0.144	1.000	0.570	0.165	0.466	14
Nagaland	0.265	0.253	0.702	0.299	0.095	0.582	28
Orrisa	0.334	0.169	0.582	0.331	0.079	0.556	23
Pondicherry	0.280	0.428	0.496		0.195	0.559	24
Punjab	0.323	0.305		0.657	0.172	0.537	20
Rajasthan	0.353	0.241		0.302	0.168	0.713	32
Sikkim	0.528	0.319		0.654	0.246	0.361	8
Tamil Nadu	0.375	0.344	0.613	0.245	0.160	0.530	19
Tripura	0.183	0.669	0.500	0.352	0.160	0.508	15
Uttar Pradesh	0.801	0.342		0.416	0.221	0.367	10
Uttarakhand	0.263	0.203		0.251	0.138	0.689	31
West Bengal	0.222	0.217	0.412	0.520	0.145	0.305	5

Source: APEDA, 2008.

The shares of different crop groups have been predicted (Table 13) using transition probability matrix for the period of 2000-01 to 2011-12. A comparison with the available actual values validated the model as there was no significant difference between observed and predicted shares for any particular crop group in concerned year as verified by  $\chi^2$  test. This implies that the observed and predicted values of crop groups are identically distributed. On the basis of these findings, projections of the shares for existing crop groups for the years 2007-08 to 2011-12 have been made with necessary assumptions that the same forces for change which existed during the period of analysis will prevail in the future. The results show that the share of fruits, vegetables, plantation crops and spices would continuously increase, while the share of field crops would decline and the share of nuts and flowers would be constant during the Eleventh Five Year Plan period. It is noted that the impact of the Horticulture Mission scheme was not captured in the present study because the scheme was initiated in a later period, 2005-06. Therefore, the actual share of horticultural groups would be much higher due to the impact of the Horticulture Mission scheme.

TABLE 13. OBSERVED AND ESTIMATED SHARE OF DIFFERENT GROUP OF CROPS IN INDIA FOR THE ELEVENTH FIVE YEAR PLAN

Year (1)	Fruits		Vegetables		Flowers		Nuts		Plantation		Spices		Field crops	
	O (2)	E (3)	O (4)	E (5)	O (6)	E (7)	O (8)	E (9)	O (10)	E (11)	O (12)	E (13)	O (14)	E (15)
1999-2000	1.87		2.96		0.04		0.06		1.38		1.23		92.46	
2000-01	1.94	1.94	3.13	3.13	0.05	0.05	0.06	0.06	1.43	1.43	1.25	1.42	92.15	91.97
2001-02	1.98	2.05	3.03	3.23	0.05	0.05	0.06	0.06	1.47	1.51	1.59	1.48	91.82	91.63
2002-03	2.01	2.15	3.23	3.30	0.04	0.05	0.06	0.06	1.58	1.55	1.70	1.55	91.39	91.34
2003-04	2.27	2.24	3.06	3.36	0.05	0.06	0.05	0.06	1.50	1.58	2.50	1.59	90.57	91.11
2004-05	2.46	2.32	3.28	3.42	0.06	0.06	0.05	0.06	1.53	1.61	1.53	1.62	91.08	90.92
2005-06	2.65	2.39	3.44	3.46	0.06	0.06	0.06	0.06	1.58	1.63	1.37	1.65	90.84	90.75
2006-07		2.45		3.50		0.06		0.06		1.65		1.67		90.61
2007-08		2.45		3.50		0.06		0.06		1.65		1.67		90.61
2008-09		2.50		3.54		0.06		0.06		1.67		1.69		90.48
2009-10		2.54		3.57		0.06		0.06		1.68		1.71		90.37
2010-11		2.58		3.60		0.06		0.06		1.70		1.72		90.28
2011-12		2.61		3.62		0.06		0.06		1.71		1.74		90.20

Source: Author's calculations.

Note: O = Observed value, E = Estimated value; ( $X^2$  cal: 5.13,  $X^2$  tab. at 30 d. f. 5 % : 43.8)

#### IV

#### CONCLUSIONS AND POLICY IMPLICATIONS

The focus of the present study is on the role of the horticultural sector of the country and its prospects during the Eleventh Five Year Plan period. The study showed that high value commodities contributed substantially in national agricultural



exports and around half of this is shared by horticultural commodities. The growth and variability of area, production and yield of major horticultural sub-sectors indicates that substantial growth has occurred in the area of all the sub-sectors during entire period (1991-92 to 2005-06). The maximum growth in area was observed for spices, followed by fruits, plantation crops and vegetables, respectively. The growth in area and variability were found to be positively correlated. Greater diversification has taken place in the horticulture sector relative to the field crops sector. Therefore, it is suggested that diversification of agriculture would be increased through inclusion of horticultural crops in the cropping pattern.

The shares of existing crop groups have been predicted using first order Markov Chain model for the period 2000-01 to 2011-12. The results indicate that the share of fruits, vegetables, plantation and spices crops would continuously increase, while the share of field crops would decline and the share of nuts and flowers would be constant during the Eleventh Five Year Plan period. It is noted that the impact of the Horticulture Mission is not reflected in the predicted shares as the scheme was started in a later period and its impact was not captured in the transition probability matrix employed in the Markov analysis. Hence the actual shares of horticultural groups would be even higher on account of the impact the Horticulture Mission and other development schemes. Area specific policy interventions based on area specific constraints are required for the sector's development. The development of the horticulture sector is essential to achieve the targets of agricultural growth and exports, food and nutritional security, and ultimately efficient utilisation of natural resources.

#### REFERENCES

- Agricultural and Processed Food Products Export Development Authority (APEDA) (2008), Ministry of Food Processing Industries, Government of India.
- Ashalatha (2004), "Direction and Changing Pattern of Indian Cashew Trade: An Application of Markov Analysis", *International Journal of Applied Economics and Econometrics*, Vol.12, No.3, pp. 557-572.
- Buckwell, A.E. and D.M. Shucksmith (1979), "Projecting Farm Structure Change", *Journal of Agricultural Economics*, Vol.30, pp. 131-43.
- Buckwell, A.E. and D.M. Shucksmith and D.A. Young (1983), "Structural Projections of The Scottish Dairy Industry Using Micro and Macro Markov Transition Matrices", *Journal of Agricultural Economics*, Vol.34, No.1, January-March, pp. 57-69.
- CGIAR (2005), *CGIAR System Research Priorities 2005-2015*, CGIAR Science Council Secretariat, pp. 96.
- Centre for Monitoring Indian Economy, *Foreign Trade and Balance of Payments*, Mumbai (various issues).
- Colman, D.R. (1967), "The Application of Markov Chain Analysis to Structural Change in the Northwest Dairy Industry", *Journal of Agricultural Economics*, Vol.18, pp. 351-361.
- Colman, D. and Dennis Leech (1970), "A Forecast of Milk Supply in England and Wales", *Journal of Agricultural Economics*, Vol.18, No.3, pp. 351-361.
- Farris, P.L. and Daniel I. Padberg (1964), "Measures of Market Structure Change in the Florida Fresh Citrus Packing Industry", *Agricultural Economics Research*, Vol.16, No.3, pp. 93-102.

- Government of India (2006), *Statewise Estimates of Value of Output for Agriculture and Livestock (1990-91 to 2002-03)*, Central Statistical Organisation, Ministry of Statistics and Programme Implementation, New Delhi.
- Government of India (2007), *Agricultural Statistics at a Glance*, Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi.
- Government of India (2007), *Indian Horticulture Database*, National Horticulture Board, Ministry of Agriculture, New Delhi.
- Government of India (2007), *Report of the Working Group on Horticulture, Plantation Crops and Organic farming for the XI Five Year Plan (2007-12)*, Planning Commission, New Delhi.
- Government of India (2008), *Economic Survey (2007-8)*, Ministry of Finance, New Delhi.
- Government of India (2008), *Eleventh Five Year Plan (2007-12) Document*, Vol. 3, Planning Commission, New Delhi.
- ICAR (2005), *Handbook of Horticulture*, Directorate of Information and Publications of Agriculture, Krishi Anusandhan Bhavan, New Delhi.
- Joshi, P.K., Laxmi Tewari and P.S. Birthal (2006), "Diversification and Its Impact on Smallholders: Evidence from a Study on Vegetable Production", *Agricultural Economics Research Review*, Vol.19, No.2, pp. 219-236.
- Kar, A., M. Singh and A.K. Ray (2003), "Linkages Between Crop Diversification and Poverty in Indian States", *Agricultural Situation in India*, Vol.60, No.8, November.
- Kendall, M.G. and A. Stuart (1961), *The Advanced Theory of Statistics*, Charles Griffin and Co. Ltd., London.
- Krenz, R.D. (1964), "Projections of Farm Numbers for North Dakota with Markov Chains", *Agricultural Economics Research*, Vol.16, No.3, pp.77-83.
- Mahadevaiah, G.S., P.C. Ravi and P.G. Chengappa (2005), "Stability Analysis of Raw Cotton Export Markets of India-Markov Chain Approach", *Agricultural Economics Research Review*, Vol.18, No.2, pp. 253-259.
- Mellor, C.J. (1984) "An Application and Extension of the Markov Chain Model to Cereal Production", *Journal of Agricultural Economics*, Vol.35, No.2, pp. 203-217.
- Murthy, S.D. and K.V. Subrahmanyam (1999), "Onion Exports Markets and their Stability for Increasing India's Exports: Markov Chain Approach", *Agricultural Economics Research Review*, Vol.12, No. 2, pp. 118-128.
- Power, A.P. and S.A. Harris (1971), "An Application of Markov Chains to Farm Type Structural Data in England and Wales", *Journal of Agricultural Economics*, Vol.22, pp. 163-177.
- Prasad Y.E., Lalith Achoth and Y. Radha (1997), "Farm Technology in Relation to Changing Structure of Land Holdings in Andhra Pradesh", *Agricultural Economics Research Review*, Vol.10, No.1, pp.78-87.
- Singh, M. (2001) "Sustainability of Rice-Wheat System in Eastern Uttar Pradesh: An Economic Perspective", Ph. D. dissertation, Indian Agricultural Research Institute, New Delhi.
- The Economic Times (2008), *Union Budget 2008-09*, March 1, New Delhi.
- World Bank (2007), *From Competition at Home to Competing Abroad: A Case Study of India's Horticulture*, Oxford University Press, New Delhi.
- Internet Web Sites  
<http://apeda.com>;  
<http://nhb.gov.in>;  
<http://planningcommission.nic.in>;  
<http://www.mospi.nic.in>