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Patterns, Determinants and Challenges of Horticulture Diversification in India

Akshay Meena[1], Ajay Kumar Meena[2], Anita Meena[1]

1. Department of Economics, University of Rajasthan, Jaipur-302004, India
2. Directorate, Planning Department, Jaipur-302005, India

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Corresponding author:
Anita Meena
anu_economics@yahoo.com

ABSTRACT

This study attempts to analyze the trends and patterns of horticulture diversification in India, the differences between states in diversification toward high value crops, and identify the factors influencing horticulture diversification. Herfindahl–Hirschman index (HHI) and Simpson Index of Diversification (SID) are employed to evaluate the extent of diversification towards horticulture crops and regression analysis is performed to assess the factors affecting horticulture diversification in India. The results reveal that total horticulture crops have shown moderate diversification. Among horticulture crops, Fruits, plantation crops and spices have exhibited high diversification, whereas high and moderate diversification have been recorded for vegetables during the period under study. The states Assam, Andhra Pradesh, Arunachal Pradesh, Bihar, Gujrat, Kerala, Karnataka, Chhattisgarh, Meghalaya, Madhya Pradesh, Mizoram, Maharashtra, Manipur, Nagaland, Rajasthan, Odisha, Sikkim, Tripura, Telangana, Tamil Nadu, Uttar Pradesh have shown high diversification whereas Jammu & Kashmir, Himachal Pradesh, Haryana, Punjab, Jharkhand, West Bengal, Uttarakhand have displayed moderate diversification in the year 2020-21. Per capita income, annual rainfall, and lagged SID for total horticulture crops all have positive effects on horticulture diversification, whereas fertilizer consumption has a negative effect.

SARI PATI

Studi ini mencoba menganalisis tren dan pola diversifikasi hortikultura di India, perbedaan antar negara dalam diversifikasi terhadap tanaman bernilai tinggi, dan mengidentifikasi faktor-faktor yang mempengaruhi diversifikasi hortikultura. Indeks Herfindahl–Hirschman (HHI) dan Indeks Diversifikasi Simpson (SID) digunakan untuk mengevaluasi tingkat diversifikasi terhadap tanaman hortikultura dan analisis regresi dilakukan untuk menilai faktor-faktor yang mempengaruhi diversifikasi hortikultura di India. Hasil menunjukkan bahwa total tanaman hortikultura telah menunjukkan diversifikasi moderat. Di antara tanaman hortikultura, buah-buahan, tanaman perkebunan dan rempah-rempah menunjukkan diversifikasi tinggi, sedangkan diversifikasi tinggi dan sedang tercatat untuk sayuran selama periode penelitian. Negara bagian Assam, Andhra Pradesh, Arunachal Pradesh, Bihar, Gujrat, Kerala, Karnataka, Chhattisgarh, Meghalaya, Madhya Pradesh, Mizoram, Maharashtra, Manipur, Nagaland, Rajasthan, Odisha, Sikkim, Tripura, Telangana, Tamil

Nadu, Uttar Pradesh telah menunjukkan diversifikasi tinggi sedangkan Jammu & Kashmir, Himachal Pradesh, Haryana, Punjab, Jharkhand, Benggala Barat, Uttarakhand telah menunjukkan diversifikasi moderat pada tahun 2020-21. Pendapatan per kapita, curah hujan tahunan, dan lag SID untuk total tanaman hortikultura berpengaruh positif terhadap diversifikasi hortikultura, sedangkan konsumsi pupuk berpengaruh negatif.

INTRODUCTION

Horticulture is the most promising sector due to its potential to generate high income and value addition for the marginal and small-scale farmers of the country. Growing urbanization, an increase in per capita income, and a shift in dietary choiceshave shifted the demand for livestock and horticulture products over foodgrains. Horticulture entails the cultivation of a wide variety of crops, including fruit crops, vegetable crops, ornamental crops, medicinal and aromatic crops, spices, and plantation crops, which are characterised by high productivity, higher return, job creation, high export earnings, small land requirements, and low water needs. In the mid-1980s, the Government of India recognised the need for diversification in the horticulture sector by concentrating its attention on investment in this sector. (Horticulture Statistics at a Glance 2018). Following the reforms of 1991, horticultural growth increased. Small and marginal farmers shifted from cultivating foodgrains to horticulture crops to satisfy the rising demand for horticultural produce. Consequently, the country's acreage under these crops has increased considerably from 12.77 million ha in 1991-92 to 28.08 million ha in the third advance estimates for 2021-22. The value of output of horticulture crops at constant prices increased from 347300 crore in 2011-12 to 466000 crore in 2019-20, registering a compound annual growth rate of 3.74 percent (Department of Agriculture & Farmers Welfare, GOI). Since 2012-13, horticulture production has consistently exceeded foodgrain production in the country (figure 1). The reasons can be attributed to the increased demand of fruits and vegetables.

The transition from traditional crops to horticulture crops is primarily the result of supply and demand-

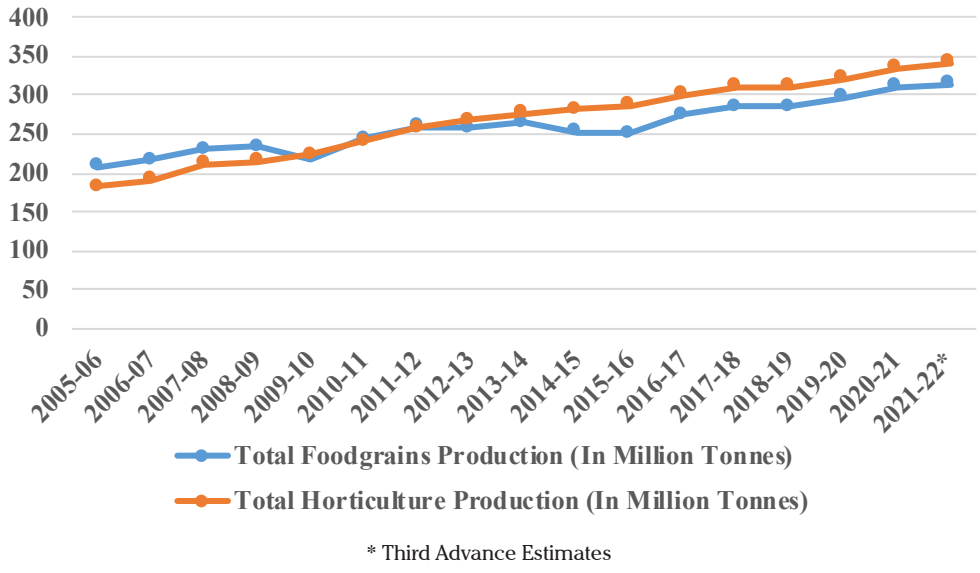

Figure1: Shift in production from foodgrains towards horticulture crops in India (2005-06 to 2021-22)

driven factors. The supply-side variables include irrigation, average precipitation, use of chemical fertilizers, average landholding size, agricultural credit, and labour rate. The demand-side drivers are population density, urbanization, per capita income, and marketing infrastructure (Hassan, B. et al. 2021). Despite the fact that horticulture commodities are gaining prominence due to their high demand and significant contribution to the agriculture sector's gross domestic product, there are still challenges to overcome. High post-harvest losses, a lack of supply chain infrastructures such as cold storage and well-connected transport networks, price seasonality and volatility, the absence of a procurement policy, a large number of intermediaries, marketing constraints, a lack of technological advancement, floods and droughts, insufficient marketing intelligence, and the absence of a processing industry are the most significant obstacles. Each issue necessitates a distinct course of action for the sustainable growth of this sector. The present paper seeks to assess the trends and patterns of horticultural diversification in India, the differences between states in diversification towards high-value crops and to identify the factors that influence horticultural diversification.

LITERATURE REVIEW

Ghosh et al. (2014) investigated the numerous facets of agricultural diversification in eastern India, focusing on the states of Assam, Bihar, Jharkhand, Orissa, and West Bengal. The lack of feasibility of small farms, shortages in accessible commodities, extension services, marketing networks, and amenities were identified as the primary causes of the region's persistently low productivity, poverty, and growing regional disparities. In addition, the study revealed that the diversification of agriculture in the eastern region involved non-cereal products and, to a lesser extent, livestock.

Hassan et al. (2021) studied the growth of the horticulture industry in India and its role as the primary growth stimulant for the agricultural sector. The relationship between horticultural diversification and the proportion of landholdings was examined using fixed effect regression. The results demonstrated that horticulture diversification is greater among small and marginal farmers who earn only one-third of their income from agriculture.

Hassan et al. (2021) investigated the effects of COVID-19 on the pre-harvesting, harvesting, and post-harvesting phases of the supply chain for key horticultural crops in Jammu and Kashmir, India.The results of the study indicated that the persistence of COVID-19 is severely impeding the efficiency of the supply chain for horticultural commodities in Jammu and Kashmir. The profitability of the horticulture industry as a whole is taking a significant hit, which will have repercussions in the future years. To restore some normalcy to the sector, the study recommended that the government increase infrastructure, provide timely input to farmers, and provide a financial stimulus.

Lone (2013) evaluated the macro-level effects of crop diversification and the determinants of agricultural diversification in general, with a focus on South Asian nations. The study utilized the Simpson index of diversification to determine crop diversification toward high-value commodities. Rising per capita income, shifting food consumption patterns, increasing urbanization, and the ongoing development of infrastructure, particularly roads were identified as the primary drivers of agricultural diversification towards high-value crops by the study's findings. While the rate of diversification differs from country to country, the direction of change is universal.

Mitra & Panda (2020) analyzed the short run and long run relationship between horticulture and economic growth in India using advanced econometric techniques such as the Granger Causality Test, the Johansen Cointegration Test, the VECM model, and OLS. The results of the Granger Causality test indicated that there is no cause-and-effect relationship between the three variables, foodgrain production, GDP, and

horticulture production. The Vector Error Correction model revealed that, with the exception of the relationship between horticulture production and GDP, there was no significant short-run relationship between variables. The Johansen Cointegration test revealed a co-integrating relationship between the variables. The OLS test results revealed a significant relationship between GDP and horticulture production. In order to increase the contribution of horticulture to the nation's gross domestic product, the study recommends increasing the number of processing units and instituting a robust supply chain management system.

Tamburini et al. (2020) examined the impact of multiple agricultural diversification practices on biodiversity and associated ecosystem services and compared them to cropping systems with less diverse farming practices. Several original investigations were evaluated using first- and second-order meta-analyses in this study. The study showed that diversification increases biodiversity, pollination, insect control, nutrient cycling, soil fertility, and water regulation without diminishing crop yields, according to the study. The study concluded that widespread adoption of diversification practices contributes to local and global biodiversity conservation and food security.

Tiwari et al. (2021) analyzed the changing patterns and trends in the growth of the horticulture sector, the vulnerability and volatility in prices of horticulture commodities, and issues pertaining to the horticulture marketing channels, with a particular focus on TOP crops. The study revealed that India's horticultural production has more than doubled between 2001-02 and 2020-21, while dietary grain production has increased relatively less during the same period. Onion had the highest price volatility, followed by tomato, while tomato has the highest price seasonality. Potato has the highest storage capacity but the lowest price volatility among the top commodities. The study also highlighted the numerous initiatives taken by the Indian government to address the problems in the horticulture sector, such as Operation Green, the Agriculture Infrastructure Fund, and the PM Kisan Sampada Yojana.

Waha et al. (2017) investigated the association between agricultural diversity and food availability in Africa. The study also examined the diversification potential and limitations of African agriculture at both the continental and household levels. The study demonstrated a positive relationship between food availability and agricultural diversity, but only up to a certain level of diversity. The study suggested that Africa requires a critical approach to enhance farming and crop diversification. Price and credit incentives as well as certified programs can help to increase agricultural diversity.

METHODS

The study assessing the trends, patterns and determinants of diversification towards horticulture crops in India is based on time series data ranging from 2001-02 to 2018-19 depending on data availability. The data forurban population is collected from World Bank and per capita income from Economic Survey 2022-23. Statistics on area under major horticulture crops, fertilizer consumption, the proportion of gross irrigated area (GIA) to gross cropped area (GCA), and annual rainfall are collected from the Department of Agriculture, Cooperation, and Farmers Welfare, the Ministry of Agriculture and Farmers Welfare, and the National Horticulture Board.

To assess the extent of diversification towards horticulture crops, Herfindahl–Hirschman index (HHI) and Simpson Index of Diversification (SID) have been used.

$$HHI = \Sigma (n/N)^2$$

Where, HHI is theHerfindahl–Hirschman index, n is the actual area under crop and N is the gross copped area. HHI varies between 0 and 1. The value near to 1 indicates perfect crop specialization, when it is near to 0 shows perfect crop diversification.

The Simpson index is given by:

$$SID = 1 - \Sigma Pi^2$$

Where SID is the Simpson Index of Diversification and *Pi* is the ratio of the ith crop's area to the total area. When SID is near to one, diversification is high, and when it is closer to zero, there is no diversification.

The following model is applied to the time series data to examine the determinants ofhorticulture crop diversification in India:

SID= f (Urb, PI, FC, Ir, Ar)

Where, Urb is urban population as a percentage of total population, PI is per capita income in rupees, FC is fertilizer consumption in kg per hectare of GCA, Ir is ratio of GIA to GCA and Ar indicates annual rainfall in millimeter. The multiple linear regression model is employed to examine how different factors affect horticulture crop diversification in India.

RESULTS AND DISCUSSION

Patterns of Horticulture Diversification in India.

Table-1 displays variations in the proportion of land devoted to horticultural crops. It is evident from the table that area under fruits in India has significantly increased from 4.01 million hectares in 2001-02 to 6.59 million hectares in 2018-19, registering anannual compound growth rate of 2.97 percent. Vegetable crops account for the major share in horticulture crops. Area under vegetable crops has increased from 6.16 million hectares in 2001-02 to 10.07 million hectares in 2018-19. The area grew by 2.93 percent per annum during the last 18 years. The floriculture has experienced significant expansion

Table 1. Changes in Proportion of Area under Horticulture Crops from2001-02 to 2018-19.

(Million hectares)

Year	Fruits	Vegetables	Flower, Aromatic & Medicinal	Plantation crops	Spices	Total Horticultural crops	Gross cropped area	Area of horticulture crops in gross cropped area (%)
2001-02	4.01	6.16	0.11	2.98	3.22	16.59	188.01	8.82
2002-03	3.79	6.09	0.07	2.98	3.22	16.27	173.89	9.36
2003-04	4.66	6.08	0.10	3.10	5.16	19.21	189.66	10.13
2004-05	5.05	6.74	0.12	3.15	3.15	18.45	191.10	9.65
2005-06	5.32	7.21	0.39	3.28	2.37	18.71	192.74	9.71
2006-07	5.55	7.58	0.47	3.21	2.45	19.39	192.38	10.08
2007-08	5.86	7.85	0.56	3.19	2.62	20.21	195.22	10.35
2008-09	6.10	7.98	0.60	3.22	2.63	20.66	195.33*	10.58
2009-10	6.33	7.99	0.69	3.27	2.46	20.88	189.19*	11.04
2010-11	6.38	8.50	0.70	3.31	2.94	21.83	197.68*	11.04
2011-12	6.71	8.99	0.76	3.58	3.21	23.24	195.80*	11.87
2012-13	6.98	9.21	0.79	3.64	3.08	23.69	194.22*	12.20
2013-14	7.22	9.40	0.75	3.68	3.16	24.20	200.95*	12.04
2014-15	6.11	9.54	0.91	3.53	3.32	23.41	198.38*	11.80
2015-16	6.30	10.11	0.91	3.68	3.47	24.47	197.05*	12.42
2016-17	6.37	10.24	0.97	3.60	3.67	24.85	200.20*	12.41
2017-18	6.51	10.26	1.04	3.74	3.88	25.43	199.99*	12.72
2018-19	6.59	10.07	0.93	4.06	4.06	25.73	197.32*	13.04

* Provisional

Source: Directorate of Economics & statistics, Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare

in recent years. The area under flower, aromatic and medicinal crops has increased from 0.11 million hectares in 2001-02 to 0.93 million hectares in 2018-19, registering a compound growth rate of 13.38 percent. During the study period, there was a 1.84 percent increase in the area of plantation crops. The area under spices increased from 3.22 million hectares in 2001-02 to 4.06 million hectares in 2018-19 with a CAGR of 1.37 percent. The table also indicates that the proportion of total cropped area devoted to horticulture has increased from 8.82 percent in 2001-2002 to 13.04 percent in 2018-2019. In 2004-2005, 2013-2014, and 2014-2015, the proportion of total cropped area devoted to horticultural crops declined marginally. Reasons include a slight decline in the proportion of area devoted to spices in 2004-05, flower, aromatic, and medicinal crops in 2013-14, and fruits in 2014-15.

The study has calculated the Herfindahl–Hirschman index (HHI) and Simpson index (SID) for horticultural crops from 2001-02 to 2018-19. (Table 2). According to Herphindal's formula, the index value fluctuates between 0.257 and 0.280, indicating a moderate degree of diversification of horticultural crops during the study period. During the study period, fruits, plantation crops, and spices exhibited high diversification, whereas vegetables displayed both high and moderate diversification. The HHI value for fruits has increased marginally from 0.058 in 2001-02 to 0.066 in 2018-19. Vegetables have experienced a slight increase in index value, from 0.138 in 2001-02 to 0.153 in 2018-2019. The index value for plantation crops decreased marginally from 0.032 in 2001-02 to 0.024 in 2018-2019. From 0.038 in 2001-02 to 0.025 in 2018-2019, spices have experienced a small decline.

Table 2. Herfindahl–Hirschman index (HHI) and Simpson Index (SID)of horticulture crops in India from 2001-02 to 2018-19

Year	HHI for Fruit	HHI for Vegetables	HHI for Plantation crops	HHI for Spices	HHI for Total horticulture	SIDfor Total horticulture
2001-02	0.058	0.138	0.032	0.038	0.266	0.734
2002-03	0.054	0.140	0.034	0.039	0.267	0.733
2003-04	0.059	0.100	0.026	0.072	0.257	0.743
2004-05	0.075	0.133	0.029	0.029	0.266	0.734
2005-06	0.081	0.148	0.031	0.015	0.275	0.725
2006-07	0.082	0.153	0.027	0.015	0.277	0.723
2007-08	0.084	0.151	0.024	0.016	0.275	0.725
2008-09	0.087	0.149	0.024	0.016	0.276	0.724
2009-10	0.092	0.146	0.024	0.013	0.275	0.725
2010-11	0.085	0.152	0.022	0.011	0.270	0.730
2011-12	0.083	0.150	0.023	0.019	0.275	0.725
2012-13	0.087	0.151	0.023	0.016	0.277	0.723
2013-14	0.089	0.151	0.023	0.017	0.280	0.720
2014-15	0.068	0.166	0.022	0.020	0.276	0.724
2015-16	0.066	0.170	0.022	0.020	0.278	0.722
2016-17	0.066	0.169	0.021	0.021	0.277	0.723
2017-18	0.066	0.162	0.021	0.023	0.272	0.728
2018-19	0.066	0.153	0.024	0.025	0.268	0.732

Source: Author's calculations based on secondary data
Note: HHI value: <0.150 = highly diversified; (0.150-0.300) = moderately diversified; (0.301-0.450) = less diversified and >0.450 = specialized.

Diversification of Horticulture Crops in Various States in India

Simpson Indices are calculated to exhibit the horticulture diversificationacross the states of India for the years 2011-12, 2015-16, 2020-21. These estimates are shown in Table-3. In the year 2011-12, the high level of diversification has covered the states of Assam, Andhra Pradesh, Gujarat, Chhattisgarh, Kerala, Karnataka, Mizoram, Meghalaya, Madhya Pradesh, Maharashtra, Nagaland, Odisha, Rajasthan, Sikkim, Tripura and Tamil Nadu whereas moderate diversification has been found in Bihar, Arunachal Pradesh, Himachal Pradesh, Haryana, Jharkhand, Jammu & Kashmir, Manipur, Punjab, Uttarakhand, Uttar.

Pradesh (UP) and West Bengal state. Manipur and Telangana have been found to be highly diversified in 2015-16. The remaining highly diversified states were the same as in 2011-12.The states Assam, Andhra Pradesh, Arunachal Pradesh, Bihar, Gujrat, Kerala, Karnataka, Chhattisgarh, Meghalaya, Madhya Pradesh, Mizoram, Maharashtra, Manipur, Nagaland, Rajasthan, Odisha, Sikkim, Tripura, Telangana, Tamil Nadu, Uttar Pradesh have shown high diversification whereas Jammu & Kashmir, Himachal Pradesh, Haryana, Punjab, Jharkhand, West Bengal, Uttarakhand have displayed moderate diversification in the year 2020-21.The states showing a substantial rise in Simpson indices are Bihar, Arunachal Pradesh, Jharkhand, Jammu & Kashmir, Haryana, Mizoram, Meghalaya, Manipur, Maharashtra, Nagaland, Rajasthan, Odisha, Tripura, Telangana, Uttarakhand and Uttar Pradesh; whereas states exhibiting a substantial reduction in Simpson indices are Assam, Andhra Pradesh, Chhattisgarh, Kerala, Karnataka, Sikkim, Punjab, Tamil Nadu and West Bengal. Gujarat and Madhya Pradesh's Simpson indices have not changed considerably during the study period. (2011-12 to 2020-21). Among the fruit crops, the highest diversification has been observed in Rajasthan followed by Haryana, Karnataka and West Bengal in the year 2020-21. In vegetables, Arunachal Pradesh and Kerala have been observed highest diversification pattern followed by Rajasthan. In terms of spices, highest diversification has been observed in Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Kerala, Maharashtra, Manipur, Punjab, Tamil Nadu, Tripura, Uttarakhand and West Bengal

Table 3. Change in Diversification Pattern in Horticulture Crops in Various States in India from 2011-12 to 2020-21

SID index	2011-12	2015-16	2020-21
Highly diversified 0.85>	Andhra Pradesh, Assam, Chhattisgarh, Gujrat, Karnataka, Kerala, MP, Maharashtra, Meghalaya, Mizoram, Nagaland, Odisha, Rajasthan, Sikkim, Tamil Nadu, Tripura.	Andhra Pradesh, Assam, Chhattisgarh, Gujrat, Karnataka, Kerala, MP, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Rajasthan, Sikkim, Tamil Nadu, Telangana, Tripura.	Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujrat, Karnataka, Kerala, MP, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Rajasthan, Sikkim, Tamil Nadu, Telangana, Tripura, UP.
moderately diversified 0.849-0.700	Arunachal Pradesh, Bihar, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Manipur, Punjab, UP, Uttarakhand, West Bengal.	Arunachal Pradesh, Bihar, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Punjab, UP, Uttarakhand, West Bengal.	Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Punjab, Uttarakhand, West Bengal.

Source: Author's own calculation based on secondary data

followed by Andhra Pradesh, Meghalaya, Nagaland and Odisha andin plantation crops Arunachal Pradesh, Bihar, Chhattisgarh, Gujarat, Jharkhand, Nagaland and West Bengal have displayed highest diversification pattern followed by Assam, Maharashtra, Mizoram and Tripura.

Determinants of horticulture diversification

The factors affecting diversification of agriculture from traditional crops to horticulture crops are mainly supply-driven and demand driven. Infrastructure facility such as roads, markets, storage capacity, processing industry, technological development and land availability are the supply side drivers. The major demand side factors are

Table 4. Regression Results

Regression Statistics					
	Mean			Standard Deviation	
Simpson Index for total horticulture crops (Percent)	72.70			0.577	
Per Capita Income in rupees (at 2011-12 prices)	62939.00			15643.38	
Fertilizer Consumption in Kg per hectare of GCA	122.45			17.63682	
Annual Rainfall in millimeter	1107.94			90.437	
Lag SID for Horticulture Crops (Percent)	72.71			0.589	
R Square		0.467			
Adjusted R Square		0.289			
Standard Error		0.48617			
Durbin-Watson		1.525			
No. of Observations		17			

Correlations				
	Per Capita Income in rupees (at 2011-12 prices)	Fertilizer Consumption in Kg per hectare of GCA	Annual Rainfall in millimeter	Lag SID for Horticulture Crops (Percent)
Simpson Index for total horticulture crops (Percent)	-0.358	-0.556	0.163	0.634

ANOVA					
	df*	Sum of Squares	Mean Square	F	Sig.
Regression	4	2.484	0.621	2.627	0.087
Residual	12	2.836	0.236		
Total	16	5.320			

	Coefficients	Standard Error	t Stats.	Sig.	Collinearity Statistics	
					Tolerance	VIF
Intercept	33.111	22.687	1.459	0.170		
Per Capita Income in rupees (at 2011-12 prices)	8.844E-006	0.000	0.753	0.466	0.437	2.287
Fertilizer Consumption in Kg per hectare of GCA	-0.011	0.012	-0.918	0.376	0.349	2.868
Annual Rainfall in millimeter	0.001	0.001	0.476	0.643	0.845	1.183
Lag SID for Horticulture Crops (Percent)	0.544	0.293	1.854	0.088	0.494	2.025

Note: Urbanization and ratio of GIA to GCA have been removed to eliminate the problem of multicollinearity. Lag SID for horticulture crops SID(-1) is inserted into the model to remove the problem of autocorrelation.

Urbanization, per capita income, convergence of food habit and marketing infrastructures.

Specification of the Model

Using a Multiple Linear Regression Model, the effect of these factors on horticulture diversification is evaluated. Following is the econometric specification of the horticulture diversification function:

$$SID_i = \beta_0 + \beta_1 Urb_i + \beta_2 PI_i + \beta_3 FC_i + \beta_4 Ir_i + \beta_5 Ar_i + \varepsilon_i \quad \text{..... (1)}$$

Where,

SID_i = Simpson Index for total horticulture crops in Percent

Urb_i = urban population as a percentage of total population

PI_i = Per Capita Income in rupees (at 2011-12 prices)

FC_i = Fertilizer Consumption in Kg per hectare of GCA

Ir_i = Ratio of GIA to GCA

Ar_i = Annual Rainfall in millimeter

Given the equation 1; β_1, β_2, β_3, $\beta_4$and β_5 are the regression coefficients ofurban population, Per Capita Income, Fertilizer Consumption, Share of GIA to GCA and Annual Rainfall respectively.

Table 4 indicates that the key determinants of horticulture crop diversification are per capita income, fertilizer consumption, annual rainfall, and lagged SID for horticulture crops. The estimated model reveals that the factors retained in this model account for 46.7 percent of the variation in the horticulture diversification index. There is a mild positive correlation between Simpson index for total horticulture crops and annual rainfall. There is a moderate positive correlation between Simpson index for total horticulture crops and lagged SID for total horticulture crops. There is a moderately negative relationship between the Simpson index for total horticulture crops and per capita income, as well as between the Simpson index for total horticulture crops and fertilizer consumption. Income per capita, annual rainfall, and lagged SID for horticulture crops have positive effects on crop diversification, but the coefficients are not statistically significant. On the other hand, fertilizer consumption has a negative but insignificant effect on the diversification of horticultural crops.

Challenges in Horticulture Diversification

The Indian horticulture sector faces severe constraints that can be classified as production, Supply Chain, processing, and marketing. Long gestation period of the crop (especially in the case of fruit crops), low adoption of advanced agricultural practices such as soil testing, seed testing, timely irrigation, and proper harvesting time, poor knowledge about hybrid and disease resistant variety seeds, higher input costs, low adoption of advanced production technologies such as net house and poly house technologies, fragmented landholdings, and inefficient use of farm management practices are all production constraints.

Lack of cold storage, high wastage, multiple intermediaries, inadequate transportation, and lack of food safety standards are supply chain constraints. Lack of processing industry, limited capacity utilization, and absence of quality standards are constraints on processing. Poor marketing practices and infrastructure, unstable prices with no procurement policy, a lack of classification and standardization, a lack of post-harvest management technology and infrastructure, and an insufficient credit supply are marketing constraints faced by the Indian horticulture sector.

MANAGERIAL IMPLICATIONS

The development of crop-specific technologies, the identification and growth of markets, and the provision of economic incentives are necessary for the success of any diversification program. The present study will assist policymakers in implementing various strategies and policies in response to the marketing and supply chain

constraints facing the Indian horticulture sector and accelerating the rate of diversification.

CONCLUSION

The key findings that emerged from the above discussion are as follows:

The area under fruits in India has increased significantly. Vegetable crops account for the major share in horticulture crops. Area under vegetable crops has also increased by 2.93 percent per annum during the period of study. The area under flower, aromatic and medicinal crops have increased registering a compound annual growth rate of 13.38 percent. In the plantation crop category, 1.84 percent increase in area has been witnessed over the period of study. The area under spices increased with 1.37 percent CAGR.The results also reported that the proportion of total cropped area devoted to horticulture crops increased during the study period. During the study period, total horticulture crops are found to be moderately diversified. Fruits, plantation crops, and spices have exhibited high diversification among horticultural commodities, whereas high and moderate diversifications have been recorded for vegetables. The states Assam, Andhra Pradesh, Arunachal Pradesh, Bihar, Gujrat, Kerala, Karnataka, Chhattisgarh, Meghalaya, Madhya Pradesh, Mizoram, Maharashtra, Manipur, Nagaland, Rajasthan, Odisha, Sikkim, Tripura, Telangana, Tamil Nadu, Uttar Pradesh have shown high diversification whereas Jammu & Kashmir, Himachal Pradesh, Haryana, Punjab, Jharkhand, West Bengal, Uttarakhand have displayed moderate diversification in the year 2020-21. The states showing a substantial rise in Simpson indices are Bihar, Arunachal Pradesh, Jharkhand, Jammu & Kashmir, Haryana, Mizoram, Meghalaya, Manipur, Maharashtra, Nagaland, Rajasthan, Odisha, Tripura, Telangana, Uttarakhand and Uttar Pradesh; whereas states exhibiting a substantial reduction in Simpson indices are Assam, Andhra Pradesh, Chhattisgarh, Kerala, Karnataka, Sikkim, Punjab, Tamil Nadu and West Bengal. Gujarat and Madhya Pradesh's Simpson indices have not changed considerably during the study period. (2011-12 to 2020-21). Among the fruit crops, the highest diversification has been observed in Rajasthan followed by Haryana, Karnataka and West Bengal in the year 2020-21. In vegetables, Arunachal Pradesh and Kerala have been observed highest diversification pattern followed by Rajasthan. In case of spices, highest diversification has been observed in Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Kerala, Maharashtra, Manipur, Punjab, Tamil Nadu, Tripura, Uttarakhand and West Bengal followed by Andhra Pradesh, Meghalaya, Nagaland and Odisha and in plantation crops Arunachal Pradesh, Bihar, Chhattisgarh, Gujarat, Jharkhand, Nagaland and West Bengal have displayed highest diversification pattern followed by Assam, Maharashtra, Mizoram and Tripura.

The major factors influencing horticulture crop diversification are per capita income, fertilizer consumption, annual rainfall, and lagged SID for horticulture crops. Per capita income, annual rainfall, and lagged SID for total horticulture have a positive impact on horticulture crop diversification, whereas fertilizer consumption has a negative impact, albeit not a significant one.

Policy Recommendations

Diversification in the agriculture sector, particularly in the horticulture sector, has become a significant source of growth for both the sector and the nation. It has emerged as a prospective source of income growth, job creation, alleviation of poverty, and export promotion. Therefore, infrastructure development, increased research and development (R&D), technological advancement, and a more effective policy framework are necessary.

1. The growth strategy should emphasize increasing productivity through large-scale cultivation, covered farming, micro irrigation, grade planting substances, and a priority to post-harvest management and marketing of produce for enhanced price achievement.
2. Prevent distress sales subsequent to the harvest by facilitating pledge financing and marketing

credit and by strengthening the nation's agricultural marketing facilities.

3. To reduce the number of intermediaries between production and consumption centers, government programmes such as Operation Green and PM Kisan SAMPADA yojana must be properly implemented. These programmes aim to develop the horticulture sector and provide farmers with the means to manage their crops.
4. Expand food processing industries to establish value chains.
5. Eliminate information asymmetries between consumers and sellers in order to facilitate real-time price discovery between actual demand and supply.
6. Utilizing bioenergy and solid waste to make horticulture more efficient and environmentally friendly.
7. Packaging with modified atmosphere for long-term storage and transport of fruits and vegetables. ■

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REFERENCES

Anuja, A., Kumar, A., Saroj, S., & Singh, K. (2020). The Impact of Crop Diversification towards High-Value Crops on Economic Welfare of Agricultural Households in Eastern India. *CURRENT SCIENCE*, 118(10), 1575-1582.

Bhat, M. (2017). Diversification towards Horticultural Crops in Jammu and Kashmir: Micro-level Analysis of Economics and Non-Economic Factors. *IOSR Journal of Business and Management (IOSR-JBM)*, 19(10), 43-50.

Birthal, P. S., Hazrana, J., & Negi, D. S. (2020). Diversification in Indian Agriculture towards High Value Crops: Multilevel Determinants and Policy Implications. *Land Use Policy*, 91, 104427.

Department of Agriculture, Cooperation & Farmers Welfare (2020). Agricultural Statistics at a Glance, Ministry of Agriculture & Farmers Welfare, Government of India, New Delhi.

Department of Agriculture, Cooperation & Farmers Welfare (2018). Horticulture Statistics at a Glance, Ministry of Agriculture & Farmers Welfare, Government of India, New Delhi.

Ghosh, M., Sarkar, D., & Roy, B. C. (Ed.) (2014). *Diversification of Agriculture in Eastern India.* Springer.

Hassan, B., Bhattacharjee, M., & Wani, S. A. (2021). Horticulture Diversification Key to Development Role of Small and Marginal Farmers. *Economic & Political Weekly*, *56*(36), 53-59.

Hassan, B., Bhattacharjee, M., & Wani, S. A. (2021). Impact of COVID-19 on Supply Chain of Major Horticultural Crops in Jammu and Kashmir, India. A*gro Economist-An International journal,* 8(01), 63-71.

Kumar, S., & Gupta, S. (2015). Crop Diversification towards High-Value Crops in India: A State Level Empirical Analysis. *Agricultural Economics Research Review*, 28(2), 339-350.

Lone, R. A. (2013). Agricultural diversification towards high value commodities in South Asia. *International Journal of Trade & Global Business Perspectives*, *2*(4), 688-694.

Mehra, P. (2017). Sustainable Development through Diversification of Agriculture towards Horticulture, *International Journal of Economic Research*, 14(16), 175-187.

Ministry of Agriculture, Cooperation & Farmers Welfare, Annual Report 2020-21.

Mithiya, D., Mandal, K., & Bandyopadhyay, S. (2018). Diversification towards Horticulture as a Source of Income and Employment: a case study of West Bengal. *International Journal of Current Research*, 10(07), 71996-72004.

Mitra, A., & Panda, S. (2020). Horticulture and economic growth in India: An econometric analysis. Journal of Applied Horticulture, 22(3), 240-245.

Singh, R. (2015). An Analysis of Spatio-Temporal Changes in the pattern of Crop Diversification in Indian Agriculture. *International Research Journal of Social Sciences*, 4 (12), 15-20.

Tamburini, G., Bommarco, R., Wanger, T. C., Kremen, C., Van Der Heijden, M. G. A., Liebman, M., & Hallin, S. (2020). Agricultural diversification promotes multiple ecosystem services without compromising yield. *Science Advances*, *6*(45), eaba1715.

Tiwari, A., Afroz, S. B., & Kumar, V. (2021). Market vulnerabilities and potential of horticulture crops in India: With special reference to top crops. *Indian Journal of Agricultural Marketing, 35*(3), 1-20.

Waha, K., Van Wijk, M. T., Fritz, S., See, L., Thornton, P. K., Wichern, J., & Herrero, M. (2018). Agricultural diversification as an important strategy for achieving food security in Africa. *Global change biology*, 24, 3390-3400.