

Horticulture sector in Uttar Pradesh (India): Regional trends and its determinants

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Abstract

The paper examines the role of horticulture sector in Uttar Pradesh at disaggregate level from 2004-05 to 2015-16. The share of horticulture sector in gross cropped area has not only been gradually increasing but has witnessed an increase in productivity of fruits, vegetables and spices. The value of output of various types of horticultural crops grown at a regional level reveals mixed trends while the value of output of horticulture by its sub sectors has accelerated considerably with its rate being the highest in Bundelkhand as compared to the other regions. The results of regression revealed that the factors such as cold storage, agricultural markets, agricultural sector loan, expense on district level schemes, electrified villages, literacy level, net irrigated area have positive and significant impact while maximum temperature has negative but significant impact on per hectare value of output. Study concludes that shifting orientation from cereal dominance to horticultural and high value crops via the instrument of crop diversification could prove to be immensely useful in supplementing farmers' income. The development of agricultural and rural infrastructure besides value chain development and food processing in specialty agriculture can help the horticulture sector to flourish considerably in the long run.

Key words: Horticulture, panel data, rural infrastructure, regional disparities, Uttar Pradesh

Introduction

Diversification of agriculture in favour of high-value commodities/horticultural crops is emerging as a promising source of income acceleration, employment generation, poverty alleviation and export promotion. This is corroborated by a research study conducted at national level which reveals that in 2013-14, staple crops occupied 77 per cent of the gross cropped area (GCA) but contributed merely 41 per cent to total output of the crop sector. On the other hand, HVCs (fruits, vegetables, fibre, condiments, spices and sugarcane) with almost same value of output, occupied 19 per cent of gross cropped area (Chand, 2017). This illustrates the need for preference to horticultural crops than agricultural crops. Moreover horticulture encompasses favourable cropping pattern features like; utilising least amount of water, growth in dry and hilly land and having minimum risks of crop failure. Hence, the regions which receive low rainfall and are drought prone have emerged to be major hotspots for the horticulture crops. Moreover, horticulture farms are much smaller than the cereals crop farms. Consequently, this gives opportunities to small and marginal farmers to boost their income from their small landholdings.

The states like Haryana, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh and Tamil Nadu have already started focusing on horticulture in a big way. However, the focused attention on the horticulture sector dates back to the 7th Five Year Plan which led to significant increase in area, production and productivity of horticulture crops. Moreover, under the 12th five year plan, the following priority areas were proposed for horticultural development in the state like increasing horticulture growth rate from 8.37 per cent to 10.40 per cent and bringing additional 17.94 lac hectares under horticulture which includes 5.24 lac ha

of fruits, 11.50 lac ha of vegetables and 1.20 lac ha for the potato crops (Rashtriya Krishi Vikas Yojna, 2015-16).

Bringing more land under horticultural crops can help in generating adequate employment opportunities too, as cultivation of fruits and vegetables, in particular, is substantially more labour-intensive than growing cereal crops. Moreover, this sector also offers more post-harvest opportunities to add value (Joshi *et al.*, 2004; Weinberger and Lumpkin, 2005) which can be tapped efficiently with timely interventions in value chains and food processing sectors.

According to Mittal (2007), the rationale behind the recent shift, away from cereals to fruits and vegetable has been considered as economic opportunity. In the context of Uttar Pradesh as well, this opportunity needs to be utilised further as the state supports a good bio-diversity and consists of favourable agro climatic conditions for horticultural crops. It also accounts for 90 per cent of small and marginal farmers who have been highly benefitted from horticulture sector. All this can really cast a lasting impact when they are complemented with better infrastructural facilities. For instance, a study by Weinberger and Lumpkin (2007) opined that the shift towards horticulture was due to institutional supports including infrastructure while other scholars (Das, 2006; Chand, 1996) argued that it was the environmental advantages that promoted diversification from traditional crops to high value cash crops among the agricultural community. In this backdrop, it becomes essential to analyse specific objectives: (i) to study emerging growth trends of horticulture sector in terms of area, production, productivity at district and regional level, (ii) to explore impact of rural infrastructure on the performance of horticulture sector, and (iii) to suggest remedial measures for enhancing farmer's income through development of horticulture sector.

Materials and methods

Database: The present paper is based on secondary data (2004-05 to 2015-16) collected from the National Horticulture Board (NHB), Directorate of Economics and Statistics, Government of Uttar Pradesh and Ministry of Statistics and Programme Implementation (MoSPI), Government of India. The data for prices was retrieved from the Office of Economic Advisor (OEA), Ministry of Finance, GoI.

Estimation of growth rate: Compound Annual Growth Rate (CAGR) was computed at regional level from 2004-05 to 2015-16;

$$\ln(Y) = \ln(a) + t \ln(b) + u$$

Where, 'Y' is the dependent variable whose growth rate is to be estimated. 't' and 'u' are time variable and error term, respectively. 'a' and 'b' are the parameters to be estimated from sample observations. The regression coefficient b is estimated by ordinary least squares (OLS) technique. The CAGR was estimated as:

$$\text{CAGR} = \{\text{antilog}(b) - 1\} * 100$$

Panel Data Regression Model: To measure the performance of horticulture sector, the relationship between value of output by horticulture sector and its drivers was also examined at district level in UP. The dataset consisted of 70 districts of Uttar Pradesh covering time period from 2004-05 to 2015-16 (Total observation = 70 x 12 = 840 observations). To find out the relationship between per hectare value of output by horticulture sector (PHVOHS) with its drivers *i.e.*, number of cold storage (NOCS), agricultural market (AGMKT), primary sector loan in total loan distribution (PSLTL), per head zilla yojna actual expense

(PHZAE), ratio of electrified villages to total villages (ELECTV), number of schools (SCH), net irrigated area (NIA) and maximum temperature (MAXT) along with the regional dummies, panel data OLS regression model was used. All variables were taken in logarithmic form. The form of regression function is:

$$\ln(\text{PHVOHS})_{it} = \beta_0 + \beta_1 \ln(\text{NOCS})_{it} + \beta_2 \ln(\text{AGMKT})_{it} + \beta_3 \ln(\text{PSLTL})_{it} + \beta_4 \ln(\text{PHZAE})_{it} + \beta_5 \ln(\text{ELECTV})_{it} + \beta_6 \ln(\text{SCH})_{it} + \beta_7 \ln(\text{NIA})_{it} + \beta_8 \ln(\text{MAXT})_{it} + D_{1_EUP} + D_{2_CUP} + D_{3_WUP} + U_{it}$$

Here, $i = 1, 2, 3, \dots, 70$ [cross section (districts)] and $t = 1, 2, 3, \dots, 12$ [time period (years)], β_0, D_1, D_2 and D_3 are dummy variables coefficients for regions, *i.e.*, Bundelkhand, Eastern UP, Central UP and Western UP and u_{it} stochastic error term

Results and discussion

Performance of agricultural sector in Uttar Pradesh: Table 1 shows the share of crops in gross cropped area to total crop sector. Share of foodgrain, oilseeds and sugarcane was 74.45 per cent, 4.16 per cent, and 14.84 per cent whereas the share of vegetables, fruits, and spices was 4.53 per cent, 1.59 per cent, and 0.43 per cent, respectively in Western UP (WUP) during 2004-05 to 2015-16. On the other hand, the share of gross cropped area of foodgrain, oilseeds and sugarcane accounted for 90.40 per cent, 1.54 per cent, and 4.71 per cent, respectively while vegetables, fruits and spices reported 2.04 per cent, 1.24 per cent, and 0.07 per cent share of gross cropped area, respectively in Eastern UP (EUP). With regards to Central UP (CUP), the share of foodgrain, oilseeds and sugarcane was 79.87, 5.55 and 10.03 per cent whereas the share of vegetables, fruits and

Table 1. Percentage share of crop sector at regional level in Uttar Pradesh (UP)

Crop Group/ Region	Foodgrain	Oilseeds	Sugarcane	Vegetables	Fruits	Spices	Total
Share in gross cropped area (Average 2004-05 to 2015-16)							
Western UP	74.45	4.16	14.84	4.53	1.59	0.43	100
Eastern UP	90.40	1.54	4.71	2.04	1.24	0.07	100
Central UP	79.87	5.55	10.03	2.34	1.92	0.29	100
Bundelkhand	82.87	12.62	0.35	4.02	0.08	0.05	100
Uttar Pradesh	81.89	4.33	8.95	3.21	1.38	0.24	100
Share in real value of output (Average 2004-05 to 2015-16)							
Western UP	40.07	2.61	38.15	9.54	8.52	1.11	100
Eastern UP	65.82	1.05	17.19	6.82	8.98	0.14	100
Central UP	47.68	2.72	28.94	5.99	14.28	0.39	100
Bundelkhand	71.64	5.91	1.10	20.68	0.52	0.14	100
Uttar Pradesh	50.51	2.42	28.35	8.88	9.20	0.65	100
Compound annual growth rate (CAGR) of real value of output							
Western UP	0.80	2.46	6.21	3.84	4.83	4.40	3.57
Eastern UP	2.26	2.45	7.60	3.33	3.70	-1.02	3.37
Central UP	0.93	4.62	7.58	1.71	0.32	1.11	2.79
Bundelkhand	3.53	9.35	10.27	9.12	5.75	6.00	5.21
Uttar Pradesh	1.54	3.98	6.94	4.30	2.98	3.65	3.52
Share in overall growth							
Western UP	8.98	1.80	66.40	10.26	11.52	1.37	100
Eastern UP	44.16	0.76	38.74	6.73	9.86	-0.04	100
Central UP	15.83	4.51	74.56	3.67	1.65	0.15	100
Bundelkhand	48.46	10.61	2.17	36.58	1.58	0.16	100
Uttar Pradesh	22.05	2.74	55.94	10.86	7.80	0.67	100

Source: Author's own calculation based on UPDES database

spices accounted for 2.34, 1.92 and 0.29 per cent, respectively. Considering the Bundelkhand region, the share in gross cropped area for foodgrain, oilseeds and sugarcane was 82.87, 12.62 and 0.35 per cent while vegetables, fruits and spices reported 4.02, 0.08 and 0.05 per cent share, respectively.

On the other hand, the share of foodgrain, oilseeds and sugarcane was 81.89, 4.33 and 8.95 per cent while vegetables, fruits and spices reported 3.21, 1.38 and 0.24 per cent share, respectively in Uttar Pradesh during the study period.

Further, the share in real value of output by crop sector at regional level in state (Table 1) revealed that the share in real value of output for foodgrain, oilseeds and sugarcane was 40.07, 2.61 and 38.15 per cent whereas the share of vegetables, fruits and spices was 9.54, 8.52 and 1.11 per cent, respectively in WUP during the study period. Similarly, the share of foodgrain, oilseeds and sugarcane accounted for 65.82, 1.05 and 17.19 per cent, respectively while vegetables, fruits and spices reported 6.82, 8.98 and 0.14 per cent share, respectively in EUP. On the other hand, the share of foodgrain, oilseeds and sugarcane was 71.64, 5.91 and 1.10 per cent whereas it was 20.68, 0.52 and 0.14 per cent for vegetables, fruits and spices, respectively in CUP. In case of Bundelkhand region, the share of foodgrain, oilseeds and sugarcane was 71.64, 5.91 and 1.10 per cent while the share of vegetables, fruits and spices was 20.68, 0.52 and 0.14 per cent, respectively. In Uttar Pradesh, the share in real value of output of foodgrain, oilseeds and sugarcane was 50.51, 2.42 and 28.35 per cent whereas the share of real value of output accounted for 8.88, 9.20 and 0.65 per cent, respectively during the study period.

It is seen that in case of foodgrain, Bundelkhand has shown spectacular performance with a CAGR value of 3.53 per cent followed by 2.26 per cent in EUP, 0.93 per cent in CUP and 0.80 per cent in WUP, respectively. In case of oilseeds as well Bundelkhand is the top performer with a CAGR of 9.35 per cent followed by 4.62 per cent in CUP, 2.46 per cent in WUP and 2.45 per cent in EUP, respectively. Similarly, in case of sugarcane, the CAGR of Bundelkhand is high (10.27 per cent) followed by EUP (7.60 per cent), CUP (7.58 per cent) and WUP (6.21 per cent). For vegetables, CAGR value is highest in Bundelkhand (9.12 per cent) followed by WUP (3.84 per cent), EUP (3.33 per cent) and CUP (1.71 per cent). In case of fruits, the CAGR is high for

Bundelkhand (5.75 per cent) followed by WUP (4.83 per cent), EUP (3.70 per cent) and CUP (0.32 per cent). For spices, the CAGR is high in Bundelkhand (6 per cent) followed by WUP (4.40 per cent), CUP (1.11 per cent) and -1.02 per cent at EUP. However, in terms of share of growth, it is highest for WUP (1.37 per cent) followed by Bundelkhand (0.16 per cent), CUP (0.15 per cent) and EUP (-0.04 per cent) during the study period. It is evident from the analysis that foodgrain still remains the main contributor to crop sector. But, the share of horticulture sector *i.e.* vegetables, fruits and spices in gross cropped area is also increasing gradually though with regional disparities. Similarly, across crop groups, the share in real value of output varied at regional level. However, the share of value of output of entire allied sector comes from about 20 per cent of horticulture crops in the state. On the other hand, it is also observed that the growth of real value of output as well as share in overall growth accelerated with extensive variations in all the regions over the period of time. The disparities in the crop sector can be attributed mainly to variations in resource endowments, institutional, climatic and socio-economic factors. However, Western UP is relatively better-off as compared to other regions in Uttar Pradesh (Raman and Kumari, 2012).

Regional trends of horticulture in UP at crop level: The region level growth trends of horticultural crops from 2004-05 to 2015-16 (Table 2) discerned that the area of potato grew at the rate of 3.42 per cent in Western UP, followed by 2.07 per cent in Central UP, 0.78 per cent in Bundelkhand and 0.01 per cent in Eastern UP, respectively while production of potato accelerated at the rate of 3.39, 2.33, 1.50 and 0.54 per cent in Western, Bundelkhand, Central and Eastern regions, respectively. In case of onions, the area grew at the highest rate *i.e.* 4.33 per cent in Eastern UP and least *i.e.* -0.14 per cent in Central UP. Similarly, the area and production of vegetable crops like tomato, okra, green peas and cauliflower grew at a positive rate but with extensive regional fluctuation in Uttar Pradesh. On the other hand, the area as well as production of fruit crops *i.e.* aonla and guava grew at a positive rate while mango and banana showed accelerated but mixed trends.

In case of spices, it is witnessed that the area and production of garlic grew at highest rate of 5.32 per cent and 8.39 per cent in Central UP while it grew at a low rate *i.e.* 0.57 per cent of area and

Table 2. Growth rate of horticultural crops at regional level in Uttar Pradesh

Crops	Western UP		Eastern UP		Central UP		Bundelkhand		Uttar Pradesh	
	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
Potato	3.42	3.69	0.01	0.54	2.07	1.50	0.78	2.33	2.55	2.90
Onion	0.80	3.03	1.62	4.33	-0.14	1.90	1.20	4.90	1.03	3.54
Tomato	7.35	7.93	18.69	18.67	7.04	0.12	3.65	3.66	8.42	4.42
Okra	9.80	11.98	8.20	10.13	5.15	7.27	7.67	8.66	8.14	10.29
Green Pea	0.95	2.71	1.54	4.73	2.14	5.87	6.19	9.21	3.93	6.92
Cauliflower	6.24	6.99	5.78	7.21	5.84	6.85	11.36	13.11	6.04	7.06
Aonla	7.52	15.61	3.84	11.67	5.88	13.87	8.69	16.89	4.46	12.34
Mango	-0.03	8.30	-0.22	5.59	0.62	2.44	0.05	5.44	0.10	5.31
Banana	-5.64	13.25	15.63	17.87	27.74	30.24	27.50	29.48	8.65	18.79
Guava	9.01	17.29	12.36	13.91	13.58	15.65	8.28	8.12	10.07	16.36
Muskmelon	-0.38	-0.38	-0.27	-0.27	-2.64	-2.64	13.03	13.04	-0.57	-0.57
Garlic	0.57	3.50	4.13	7.18	5.32	8.39	3.58	6.21	0.91	3.85

Source: Author's own calculation based on UPDES database

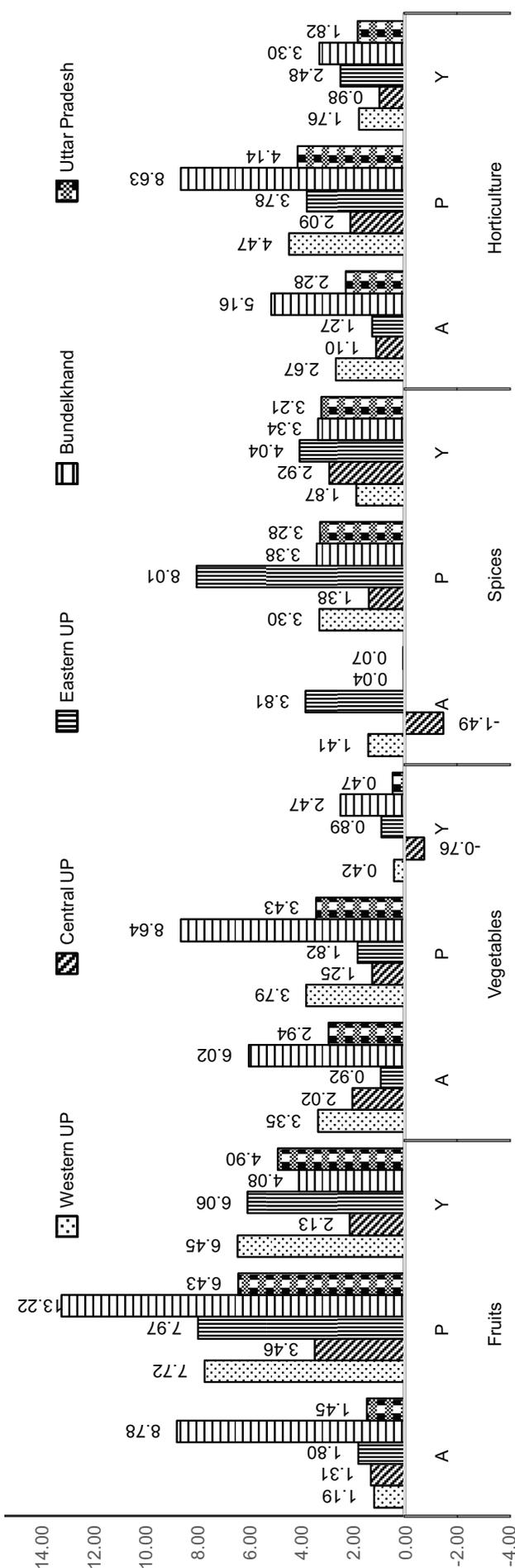


Fig. 1. Region wise growth trends of Area (A), Production (P) and Yield (Y) in horticulture and its sub sector in UP
Source: Author's own calculation based on UPDES database

3.50 per cent of production in Western UP. In Uttar Pradesh, the area of potato, onion, tomato, okra, green pea, cauliflower grew at the rate of 2.55, 1.03, 8.42, 8.14, 3.93 and 6.04 per cent, respectively while the production of potato, onion, tomato, okra, green pea, cauliflower grew at the rate of 2.90, 3.54, 4.42, 10.29, 6.92 and 7.06 per cent, respectively. Similarly, the area under aonla, mango, banana, guava and muskmelon accelerated with a rate of 4.46, 0.10, 8.65, 10.07 and -0.57 per cent, respectively whereas production of aonla, mango, banana, guava and muskmelon grew at the rate of 12.34, 5.31, 18.79, 16.36 and -0.57 per cent, respectively during the study period. On the other hand, in case of spices, the area and production of garlic grew at the rate of 0.91 and 3.85 per cent, respectively. From the analysis, it is observed that various types of horticultural crops *i.e.* vegetables, fruits and spices at regional level reveal mixed trends in area and production during the study period.

Regional trends of area, production and yield in horticulture in UP at crop group level: The varying agro-climatic conditions in Uttar Pradesh provide space to produce a wide variety of horticultural crops such as fruits, vegetables and spices. Fig. 1 represents the CAGR of area, production and yield of horticulture sub sectors at regional level in UP during 2004-05 to 2015-16. It was found that the area under fruits grew at a rate of 1.12 per cent in Western UP, followed by 1.31 per cent in Central UP, 1.8 per cent in Eastern UP and reached to highest 8.78 per cent in Bundelkhand region during the study period. Similarly, the production of fruits accelerated to 7.72 per cent in Western UP, followed by 3.46 per cent in Central UP, 7.97 per cent in Eastern UP and became highest *i.e.* 13.22 per cent in Bundelkhand region. The growth of yield for fruits was 6.45 per cent in Western UP, followed by 2.13 per cent in Central UP, 4.08 per cent in Bundelkhand and became 6.06 per cent in the Eastern UP. In case of UP altogether, the area, production and yields of fruits grew at the rate of 1.45, 6.43 and 4.90 per cent, respectively during the study period.

On the other hand, the area under vegetables accelerated with highest in Bundelkhand, followed by least in Eastern, 2.02 per cent in Central and became 3.35 per cent in Western region. In case of vegetables production, it grew at the rate of 3.79 per cent in Western UP, followed by 1.25 per cent in Central UP, 1.82 per cent in Eastern UP and reached as high as 8.64 per cent in Bundelkhand region while the productivity of vegetables accelerated at the rate of 0.42, -0.76, 2.47 and 0.89 per cent in Western, Central, Bundelkhand and Eastern regions, respectively.

Regarding area under spices, it grew at an accelerated rate of 3.41 per cent in Eastern UP, followed by 1.41 per cent in Western UP, 0.04 per cent in Bundelkhand and became negative *i.e.* -1.49 per cent in Central UP whereas production of spices grew at the rate of 8.01 per cent in Eastern UP, 3.38 per cent in Bundelkhand, 3.30 per cent in Western UP and 1.38 per cent in Central UP. However, in terms of productivity of spices, it accounted for positive growth in all the regions as well as at the state level.

The area, production and productivity of horticultural crops in Western region grew at the rate of 2.67, 4.47 and 1.76 per cent, respectively. In case of Central region, the area, production and productivity of horticulture accelerated at the rate of 1.10, 2.09 and 0.52 per cent whereas the area, production and productivity grew at the rate of 5.16, 8.63 and 3.30 per cent, respectively in Bundelkhand region.

On the other hand, the area, production and productivity of horticulture grew at an accelerated rate of 1.27, 3.78 and 2.48 per cent, respectively in Eastern region. In case of Uttar Pradesh, the area, production and productivity of horticulture grew at the rate of 2.28, 4.14 and 1.82 per cent, respectively during 2004-05 to 2015-16. In nutshell, Uttar Pradesh has witnessed an increase in horticulture area expansion resulting in higher production. However, the area, production and productivity of fruits, vegetables and spices have extensive variations across regions in Uttar Pradesh. But, there is enormous scope of improvement in horticulture sector in Uttar Pradesh.

Crop-wise regional trends of output value in horticulture: The growth rates of value of output by horticulture crops at regional level in Uttar Pradesh during 2004-05 to 2015-16 are presented in Table 3. It reveals that the value of output of potato grew at the rate of as high as 3.57 per cent in Western UP, followed by 2.36 per cent in Bundelkhand, 1.69 per cent in Central UP and was lowest *i.e.* 0.38 per cent in Eastern UP during the study period. Similarly, the value of onion grew at the highest rate *i.e.* 6.57, 5.99, 4.67 and 3.51 per cent in Bundelkhand, Eastern, Western and Central regions, respectively. The value of output of tomato accelerated to as high as 18.79 per cent in Eastern region and was lowest (0.22 per cent) in Central region while in case of okra, it grew at the rate as high as 7.51 per cent in Western UP and was lowest (2.99 per cent) in Central region over the period of time. With regards to the value of output of green pea and cauliflower, horticulture crops accounted for positive growth rates across all the regions. On the other hand, fruits like aonla, banana and guava accelerated with positive growth rate while other crops like mango and muskmelon showed mixed trends coupled with wide variations in all the regions. In case of spices, the major contributions were included by crops like garlic which grew at the rate as high as 9.94 per cent in Central UP, followed by 8.71 per cent in Eastern UP, 7.73 per cent in Bundelkhand and 4.99 per cent in Western UP. Overall, in Uttar Pradesh, the vegetables such as potato, onion, tomato, okra, green pea and cauliflower grew at the rate of 2.80, 5.24, 4.53, 5.89, 7.14 and 9.34 per cent, respectively. In case of fruit crops like aonla, mango, banana, guava and muskmelon, growth rates were 9.34, 4.32, 2.51, 12.88 and 10.07 per cent, respectively in U.P. On the other hand, garlic grew at the rate of -5.94 per cent in Uttar Pradesh during the study period. Overall, from the analysis, it is noticed that the value of output of various types of horticultural crops *i.e.* vegetables, fruits

and spices at regional level in Uttar Pradesh revealed mixed trends during the study period.

Regional trends of value of output by horticultural sub-sectors: Region wise growth trends of value of output by horticulture and its sub sector in Uttar Pradesh from 2004-05 to 2015-16 (Fig. 2) revealed that the growth of value of output of fruits grew at the rate of 5.75 per cent in Bundelkhand, followed by 4.83 per cent in Western UP, 3.70 per cent in Eastern UP and reached lowest *i.e.* 0.32 per cent in Central UP during the study period. Similarly, the value of vegetables accounted for 9.12 per cent in Bundelkhand, followed by 3.84 per cent in Western UP, 3.33 per cent in Eastern UP and became 1.71 per cent in Central UP. The value of spices accelerated to 6.0, 4.40, 1.11 and -1.02 per cent in Bundelkhand, Western, Central and Eastern regions, respectively. On the other hand, the value of output by horticulture sector grew at the rate of 9.04 per cent in Bundelkhand, followed by 4.29 per cent in Western UP, 3.51 per cent in Eastern UP and lowest *i.e.* 0.49 per cent in Central UP. Overall, in Uttar Pradesh, the value of fruits, vegetables and spices grew at the rate of 2.98, 4.30 and 3.65 per cent, respectively while the value of overall horticulture sector accounted for 3.60 per cent during the study period. Overall, from the above analysis, it is observed that value of output by horticulture and its sub sectors is highest in Bundelkhand as compared to the other regions. The growth of value of output by horticulture and its sub sector has extensive fluctuations at regional levels in Uttar Pradesh.

Panel data regression: The results of panel data OLS regression model in Uttar Pradesh during 2004-05 to 2015-16 are presented in Table 4. It reveals the relationship between per hectare value of output by horticulture sector and its drivers. The regression results highlight that the factors such as number of cold storage (NOCS), agricultural markets (AGMKT), primary sector loan in total loan distribution (PSLTL), per head zilla yojna actual expense (PHZAE), ratio of electrified villages to total villages (ELECTV), number of schools (SCH), net irrigated area (NIA) have positive and significant impact on per hectare value of output by horticulture sector during the study period. On the other hand, maximum temperature has negative but significant impact on per hectare value of output by horticulture sector during the study period.

The value of R-square is 0.3993 which implies that around 40 per cent variation in per hectare value of output by horticulture crops

Table 3. Growth rate of value of output by horticulture crops at regional level in Uttar Pradesh

Districts	Western UP	Eastern UP	Central UP	Bundelkhand	Uttar Pradesh
Potato	3.57	0.38	1.69	2.36	2.80
Onion	4.67	5.99	3.51	6.57	5.24
Tomato	8.05	18.79	0.22	3.77	4.53
Okra	7.51	5.74	2.99	4.32	5.89
Green Pea	2.92	4.95	6.08	9.43	7.14
Cauliflower	9.27	9.49	9.12	15.51	9.34
Aonla	7.35	3.70	5.74	8.54	4.32
Mango	5.42	2.78	-0.29	2.63	2.51
Banana	7.61	12.00	23.75	23.03	12.88
Guava	10.95	7.76	9.41	2.28	10.07
Muskmelon	-5.76	-5.66	-7.90	6.94	-5.94
Garlic	4.99	8.71	9.94	7.73	5.34

Source: Author's own calculation based on UPDES database

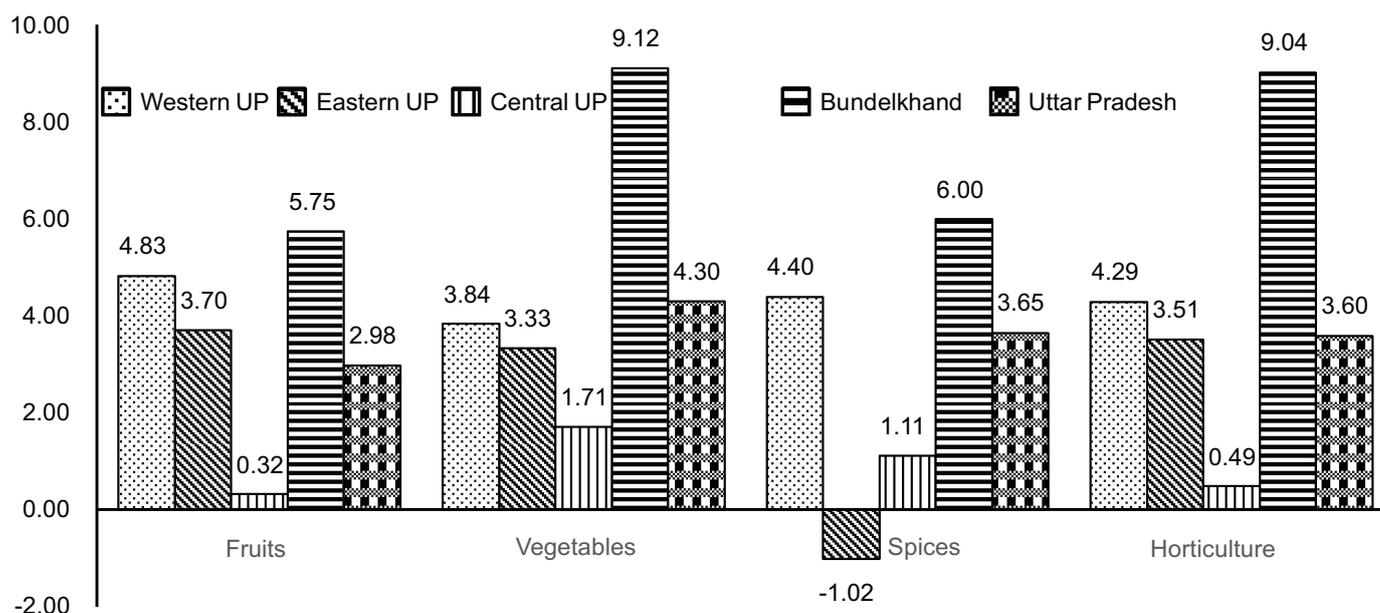


Fig. 2. Region wise growth trends of value of output by horticulture and its sub sector in UP

Source: Author's own calculation based on UPDES database

is explained by the factors at regional level in Uttar Pradesh. The magnitude of F-value shows that the given model is a good fit between per hectare value of output by horticulture sector and its variables. The variance inflation factor (VIF) value indicates the absence of multicollinearity in the regression model.

Moreover, the impact of dummy variables for Bundelkhand on per hectare value of output by horticulture sector has been found highest as compared to other dummies. Overall, from the regression results, it is clearly demonstrated that most parameters of per hectare value of output by horticulture sector *viz.*, cold storage, agricultural markets, agricultural loan, district plan actual expense, electrified villages, literacy level, net irrigated area under consideration are found to influence the nature and the extent of horticultural growth in Uttar Pradesh. Hence, interventions via public investments particularly in developing value chains and food processing can give impetus to the horticultural sector immensely.

Conclusion and policy implications: Horticulture sector has emerged as one of the driving forces for overall development of agriculture sector in Uttar Pradesh. The growth of this sector would not only create better employment opportunities, supplement farmers' income but also provide nutritional security and raise the foreign exchange reserves in the country. Though foodgrain still remains the main contributor to the crops sector, the share of horticulture by its sub sectors in gross cropped area has been increasing gradually. The value of output of various types of horticultural crops *i.e.* vegetables, fruits and spices at regional level in Uttar Pradesh reveals mixed trends while the value of output by horticulture and its sub sectors grew with highest rate in Bundelkhand as compared to the other regions. The regression results show that the factors such as cold storages, agricultural markets, agricultural loan, expense on district schemes, electrified villages, literacy level and irrigated area have positive and significant impact on per hectare value of output by horticultural sector during the study period. On the other hand, climatic

Table 4. Panel data regression result of value of output and its drivers

Dependent variable: Per hectare value of output by horticulture sector					
Source	SS	df	MS	Number of Obs. = 840	R-squared = 0.3993
Model	331.36	8	41.42	F (8, 831) = 69.05	Adj R-squared = 0.393
Residual	498.449	831	0.5998	Prob > F = 0.0000	Root MSE = 0.77448
Total	829.809	839	0.989	VIF Average = 1.425	
Independent Variable	Coefficient	Standard Error	t-Value	P> t	VIF
NOCS	0.3665	0.0238	15.38	0.0000	2.48
AGMKT	0.1716	0.0509	3.37	0.0010	1.29
PSLTL	0.2918	0.0576	5.07	0.0000	1.14
PHZAE	0.0864	0.0231	3.74	0.0000	1.07
ELECV	0.3839	0.1504	2.55	0.0110	1.15
SCH	0.2608	0.1058	2.46	0.0140	1.27
NIA	0.7698	0.1137	6.77	0.0000	1.87
MAXT	-1.4523	0.3452	-4.21	0.0000	1.13
Dummy variables for administrative regions					
Bundelkhand		7.9370		Central Uttar Pradesh	7.6020
Eastern Uttar Pradesh		7.1244		Western Uttar Pradesh	6.8955

Source: Authors Calculation

variable (maximum temperature) had negative but significant impact on per hectare value of output by horticulture sector.

Thus, in a nutshell, shifting orientation from cereal dominance to horticultural and high value crops via crop diversification can be instrumental in supplementing farmers' income. Also, up gradation of rural infrastructure with timely public interventions can be instrumental in plugging the loopholes engulfing the horticultural sector in particular and agricultural sector in general. PPP initiatives in the domain of value chains and food processing coupled with innovative extension systems to transfer right knowledge especially around natural resource management and specialty agriculture can be a major step in this regard. Moreover, a major thrust to low volume high value crops, Integrated Organic Farming System (IOFS) and low-input use areas for promotion of organic farming especially for export economy can prove to be useful in formulating holistic agricultural policies thereby enhancing farmers' income.

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