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Patterns and Progress in Horticultural Farming in Rural Areas of Uttarakhand Himalaya

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ABSTRACT

Uttarakhand grows a number of horticultural crops – fruits, vegetables, spices and flowers. Its patterns in terms of area, production and yield vary from crop to crop and from one district to other. The main objective of this paper was to examine patterns and progress of horticultural farming in rural areas of Uttarakhand. We gathered two time series (2001-2014) data from secondary sources and analyzed area, production and yield of crops. It was observed that although, there was an increase in crops' yield (13.6%), area (21.1%) and production (35.5%) yet increase in yield was comparatively less than area and production, during the period.

1. Introduction

Horticultural farming is one amongst the most economic activities in rural areas of Uttarakhand. It substitutes regional economy and supports livelihoods of rural people. Further, it has the potential to generate income and augment employment. It does not only generate income but also restores the fragile ecosystem. Climate in Uttarakhand is suitable to grow various horticultural crops in different agro-climatic zones (Sati 2004) and diversity in crop races/cultivars is quite high. However, it possesses only 4.8% area under its cultivation, of which 3.5% falls under fruits, 1.1% under vegetables, 0.2% under spices and 0.02% under flowers. In the last decades, a substantial increase in area (21.1%) and production (35.5%) of horticultural crops was noted while, yield increased by 13.6% only. In India, area under fruits and vegetables grew at an annual compound growth rate of 5.3% during the last decade (Sharma and Jain 2011). The main factors responsible for significant growth in area under fruits and vegetables were big push from the government for 'Integrated Development for Horticulture in the Himalayan States. India ranks second in horticultural production in the world.

During 2012-13, its contribution in horticultural production in the world was 12.6% with 81.2 million tonnes fruits and 162 million tonnes vegetables (IHD 2013). Ramana (2008) also observed it as the largest producer of fruits and vegetables. In rural areas of India, horticultural development plays a greater role in providing sufficient nutrition and income to farmers including marginal once (Swarup et al. 1987).

The share of agriculture in GDP (Gross Domestic Products) in India has declined substantially from 55% in the early 1950s to about 42% in the 1980s and further to 19% in 2006 (Economic Survey 2007). In the meantime, the horticulture sector has emerged as a potential sector in Indian economy. It contributes 30% to GDP in agriculture from its 8.5% area. However, yield of horticultural crops has increased only marginally from 7.5 MT/ha in 1991-92 to 8.4 MT/ha in 2004-05 (NHB 2005). Similarly, in terms of production of apple, it has gradually increased but yield has fallen from 10.8 to 5.8 t/ha (Awasthi et al. 2001). During ninth and 10th plan periods, investment in horticulture has transformed agrarian economy in many states of India (Singh, 2008). Uttarakhand's three-fourth population depends on agriculture for carrying livelihoods however, the land holdings are small and fragmented, and irrigation facilities are limited (Mittal et al. 2008).

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Practicing agriculture is the main occupation of the rural people as about 70% people live in rural areas (2011). Per ha yield of crops is very less even less than horticultural crops. Low yield of crops and insufficient food supply created food insecurity and malnutrition and thus people suffered a lot. Horticultural practices on the other hand are best suited in this ecologically fragile terrain. It can play a vital role in sustaining livelihoods of the rural people as many researchers and academicians observed that horticultural crops have potentials to improve nutrition, attain food security, generate income and augment employment (Tewari 1987; ICAR, 2005; Rai and Yadav 2005). Agricultural diversification through cultivating fruits, vegetables, spices and flowers is a pathway to harness suitable agro-climate of Uttarakhand (Brithal et al. 2006). Market is an essential force to develop horticultural farming (Vishwanadham 2006). The main purpose of this study was to examine the patterns and progress in horticultural farming in rural areas of Uttarakhand Himalaya. It assessed crop wise share of area, production and yield of horticultural crops, analyzed yield of crops at district level and suggested crops suitability indices at district level and under different agro-climatic zone.

The Area

The Uttarakhand Himalaya stretches between 28° 53' 24"-31° 27' 50" N and 77° 34' 27"-81° 02' 22" E and obtains 53,483 km² area, of which about 93% is mountainous mainland. Out of total population, 70% population lives in rural areas (2011) and their main occupation is practicing agriculture. Arable land is only 18.5%, out of which, area under horticulture is 4.8%. In Uttarakhand, altitude ranges from 200 m to above 7,000 m and it has varied agro-climates – subtropical to temperate and cold, which

supports for a sustainable horticulture.

2. Methodology

This study was conducted mainly through gathering data from secondary sources (State Directorate of Horticulture, Dehradun) on pattern and progress of horticulture. We analyzed data on area, production and yield of horticultural crops (2013-14) – fruits, vegetables, spices and flowers – and assessed yield's indices (very high, high, medium and low) at district level. A time series data (2001-2014) was analyzed to observe progress and change in area, production and yield of horticultural crops.

3. Results

Patterns of Horticultural Farming

Patterns of horticultural farming were analyzed through assessing area, production and yield of individual crops and their state wise assessment. Horticultural crops were divided into four categories *viz.* fruits, vegetables, spices and flowers. The following paragraphs analyzed patterns of horticultural farming.

Area, Production and Yield of Fruits

Table 1 shows area, production and yield of 11 fruits (2013-14). On account of % share of area, Mango ranks first (19.68) followed by apple (16.66). Citrus obtains third position (13.83) whereas walnut stands for fourth place (9.83). The lowest area is shared by plum (0.20) followed by guava (0.74). Fruits such as pear, litchi, peach, plum and apricot stand between four and eight percent area share. Other fruits occupy 12.85% area share. Production share varies from 17.16% (highest) in apple to 0.08% (lowest) in aonla fruits.

Table 1. Area, production and yield of fruits (2013-14)

Fruits	% share of area	% share of production	Yield (MT/ha)
Mango	19.68	17.08	3.47
Apple	16.66	17.16	4.12
Citrus	13.83	16.98	4.91
Walnut	9.83	2.74	1.11
Pear	7.53	13.71	7.28
Litchi	4.84	2.36	1.95
Plum	4.83	5.19	4.29
Apricot	4.55	4.05	3.56
Peach	4.46	6.13	5.49
Guava	0.74	1.13	6.06
Aonla	0.20	0.08	1.64
Others (Papaya and wild fruits)	19.52	19.68	9.96
Total	198160 (ha)	792077 (MT)	3.99

Source: State Directorate of Horticulture, Dehradun, Uttarakhand

Two fruits – mango (17.08%) and citrus (16.98%) share almost equal production close to apple. Pear bears fourth rank (13.71%). Guava (1.13%), litchi (2.36%) and walnut (2.74%) are other fruits which have low production while peach, plum and apricot share almost equal production (average 5%). Other fruits share 13.39% production. Yield of fruits varies from pear (7.28 MT/ha highest) to walnut (1.11 lowest). Guava shares 6.06 yields. It is followed by peach (5.49), citrus (4.91), plum (4.29) and apple (4.12). Apricot shares 3.56 yields and among other fruits, it is 4.17. The lowest yield of crop is shared by aonla (1.64). Average yield of fruits was noted 3.99.

Area, Production and Yield of Vegetables

There are total 10 main vegetables listed in table 2, although a number of leafy vegetables also grow. We analyzed % share of area, production and yield (MT/ha) of vegetables. In terms of % share of area, two crops – green peas and tomato – obtain first and second ranks (18.22 and 14.31, respectively). It is followed by cabbage (9.14), French bean (8.43) and radish (7.52). The lowest area is shared by brinjal (3.48) and capsicum (3.78). Three vegetables onion, okra and cauliflower have 6.15, 5.32 and 4.15 area share, respectively. In terms of production, the highest share is earned by tomato (16.01%) followed by green peas (14.33%) and cabbage (11.61%). Radish shares 9.39%. The lowest production is shared by capsicum (2.11%) followed by brinjal (4.26%) and okra (4.47%). French bean, cauliflower and onion have only 5% share (average). Production share of other vegetables (Figure 4) is 19.68%. Yield (MT/ha) of vegetable crops was analyzed. The highest yield was noted from cauliflower (13.32) followed by cabbage (12.56), radish (12.34) and Brinjal (12.1). Onion and tobacco have equal yields (11.05). The lowest yield was noted in capsicum (5.49) followed by French bean (7.63) and green peas (7.77). Okra has 8.33 yields. Other vegetables have 9.96 yields and average yield of vegetable crops is 9.88.

Area, Production and Yield of Spices

Mainly five spices grow in Uttarakhand under which a substantial area is devoted (Figure 3). Total area under spices is 10107 ha, of which the highest area is under ginger, which is 41.09% followed by chili (20.7%), coriander (14.6%) and garlic (12.5%). The lowest area is under turmeric (7.9%). Other spices have only 3.2% area. Total production of spices was 73101 MT. The highest production was noted from ginger (57.38%) followed by garlic (11.57%) and chili (10.4%). Coriander has 9.8% productions and turmeric has 9.1%. In terms of yield of spices, average yield is 7.23 MT/ha. The highest yield was

obtained from ginger (10.1) followed by turmeric (8.33) and garlic (6.67). Chili, coriander and other spices have 4 MT/ha average yield

Table 2. Area, production and yield of vegetables (2013-14)

Vegetables	% share of area	% share of production	Yield (MT/ha)
Green peas	18.22	14.33	7.77
Tomato	14.31	16.01	11.05
Cabbage	9.14	11.61	12.56
French bean	8.43	6.28	7.63
Radish	7.52	9.39	12.34
Onion	6.15	6.26	10.05
Okra	5.30	4.47	8.33
Cauliflower	4.15	5.6	13.32
Capsicum	3.78	2.11	5.49
Brinjal	3.48	4.26	12.1
Others (Table 4)	19.52	19.68	9.96
Total	61392 (ha)	606508 (MT/ha)	9.88

Source: State Directorate of Horticulture, Dehradun, Uttarakhand; Vegetables exclude potato whereas potato has the highest area.

Table 3. Area, production and yield of spices (2013-14)

Spices	% share of area	% share of production	Yield (MT/ha)
Ginger	41.09	57.38	10.1
Chili	20.7	10.4	3.7
Coriander	14.6	9.8	4.8
Garlic	12.5	11.57	6.67
Turmeric	7.9	9.1	8.33
Others	3.2	1.7	4
Total	10107 (ha)	73101 (MT)	7.23

Source: State Directorate of Horticulture, Dehradun, Uttarakhand

Area, Production and Yield of Flowers

Table 5 shows area, production and yield of flowers. Total area under flowers is 1346 ha of which, marigold's area is 43.6% which is followed by gladiolus (29.1%) and rose (10.9%). Gerbera shares 5.6% and carnation 2.2% area. Other flowers which are not listed here have 8.7% share. In terms of production, it is 5869 MT. Gerbera shares the highest production (59.3%) followed by marigold (15.1%), gladiolus (11.9%) and carnation (9.6%). Rose and other flowers share 2.4% and 1.8% respectively. We analyzed yield of flowers (MT/ha) and observed that gerbera has the highest yield (46.2). Carnation seconds it (19). Rose (1) gladiolus (1.8), marigold (1.5) and other flowers (1) have very low yield. An average yield of flowers is 4.36.

Table 4. A list of other vegetables

Local name	English name	Botanical name	Availability season
Lauki	Bottle gourd	<i>Lagenaria vulgaris</i> L.	Rainy
Gol Caddu	Pumpkin	<i>Cucurbita maxima</i> Duchesne	Rainy
Tit Karaila	Bitter gourd	<i>Momordica charantia</i> L.	Rainy
Bhindi	Lady's finger	<i>Abelmoschus esculentus</i> Moench	Rainy
Kakadi	Cucumber	<i>Cucumis sativus</i>	Rainy
Ogal	Buckwheat	<i>Fagopyrum esculentum</i> Moench	Summer
Bean	Bean	<i>Phaseolus vulgaris</i>	Summer and rainy
Lai	Indian Mustard	<i>Brassica Juncea</i> Czern & coss.	All
Methi	Fenugreek	<i>Trigonell foenum-graecum</i> L.	All
Palak	Spinach	<i>Spinacia oleracea</i> L.	Winter
Bakula	Field bean	<i>Vicia faba</i> L.	Summer
Matar	Pea	<i>Pisum sativum</i>	Winter
Aalu	Potato	<i>Solanum tuberosum</i> L.	Summer and rainy
Halang	Garden cress	<i>Lepidium sativum</i> L.	Winter
Pinalu	Cocoyam	<i>Colocasia esculenta</i> L. (Schott.)	Winter
Gaderi	Taro	<i>Colocasia</i> Sp.	Winter
Turai	Ribbed gourd	<i>Luffa acutangula</i> L. (Roxb.)	Rainy
Chaulai	Garden amaranth	<i>Amaranthus tricolor</i> L.	Summer and rainy
Chichinda	Songe gourd	<i>Luffa cylindrica</i> (L.) M. J. Roem.	Rainy

Source: by author

Table 5. Area, production and yield of flowers (2013-14)

Flowers	% share of area	% share of production	Yield (MT/ha)
Marigold	43.6	15.1	1.5
Gladiolus (cut flower 8000*/ton)	29.1	11.9	1.8
Rose (cut flower) 13000*/ton	10.9	2.4	1
Gerbera (cut flower 17500*/ton)	5.6	59.3	46.2
Carnation (cut flower 21000*/ton)	2.2	9.6	19
Others	8.7	1.8	1
Total	1346 (ha)	5869 (MT)	4.36

Source: State Directorate of Horticulture, Dehradun, Uttarakhand; *number

District Wise Levels of Yield of Horticultural Crops

Yield of all horticultural crops – fruits, vegetables, spices and flowers – were indices into four levels – very high, high, medium to low and then we placed districts under each level according to their yield value (Table 6). In terms of yield level of fruits Almora, Hardwar and Chamoli districts fall under very high yield level. Four districts – Udham Singh Nagar (USN), Uttarkashi, Bageshwar and Pithoragarh – have high yield of fruits. Medium level of yield is recorded in two districts – Nainital and Dehradun. Meanwhile four districts – Rudraprayag, Chamoli, Pauri and Tehri have low yield of fruits. Three districts – Hardwar, Pithoragarh and Uttarkashi obtain very high yield of vegetables. High yield of vegetables is observed in six districts – Dehradun, USN, Almora, Nainital, Chamoli and

Tehri whereas medium yield of vegetables was obtained by Bageshwar, Rudraprayag, Pauri and Chamoli districts. No district falls under low vegetable yield. Yield of spices varies from 3 to 10 MT/ha. Three districts such as Pithoragarh, Nainital and Hardwar obtain very high level. A number of districts – Dehradun, USN, Almora, Champawat, Uttarkashi, Chamoli and Tehri – attain high yield level. Medium level yield is observed in Bageshwar, Pauri and Rudraprayag districts. No district falls under low yield of spices. Flowers grow in all district, however, its yield varies from 1 to 12 MT/ha. Nainital and Dehradun obtain very high yield and Tehri, USN and Uttarkashi districts obtain high yield. Almora district falls under medium level yield where as Low yield was obtained in Pauri, Pithoragarh, Bageshwar, Chamoli, Champawat, Rudraprayag and Hardwar. Figure 1 also shows district wise yield of horticultural crops.

Table 6. Levels of yield of horticultural crops

Fruits		
Indices	Levels	Districts
>6	Very high	Almora, Hardwar and Chamoli
4-6	High	USN, Uttarkashi, Bageshwar and Pithoragarh
2-4	Medium	Nainital and Dehradun
<2	Low	Rudraprayag, Chamoli, Pauri and Tehri
Vegetables		
Indices	Levels	Districts
>12	Very high	Hardwar, Pithoragarh and Uttarkashi
8-12	High	Dehradun, USN, Almora, Nainital, Chamoli and Tehri
4-8	Medium	Bageshwar, Rudraprayag, Pauri and Chamoli
<4	Low	Nil
Spices		
Indices	Levels	Districts
>9	Very high	Pithoragarh, Nainital and Hardwar
6-9	High	Dehradun, USN, Almora, Champawat, Uttarkashi, Chamoli and Tehri
3-6	Medium	Bageshwar, Pauri and Rudraprayag
<3	Low	Nil
Flowers		
Indices	Levels	Districts
>9	Very high	Nainital and Dehradun
6-9	High	Tehri, USN and Uttarkashi
3-6	Medium	Almora
<3	Low	Pauri, Pithoragarh, Bageshwar, Chamoli, Champawat, Rudraprayag, Hardwar

Source: State Directorate of Horticulture, Dehradun; assessed by author

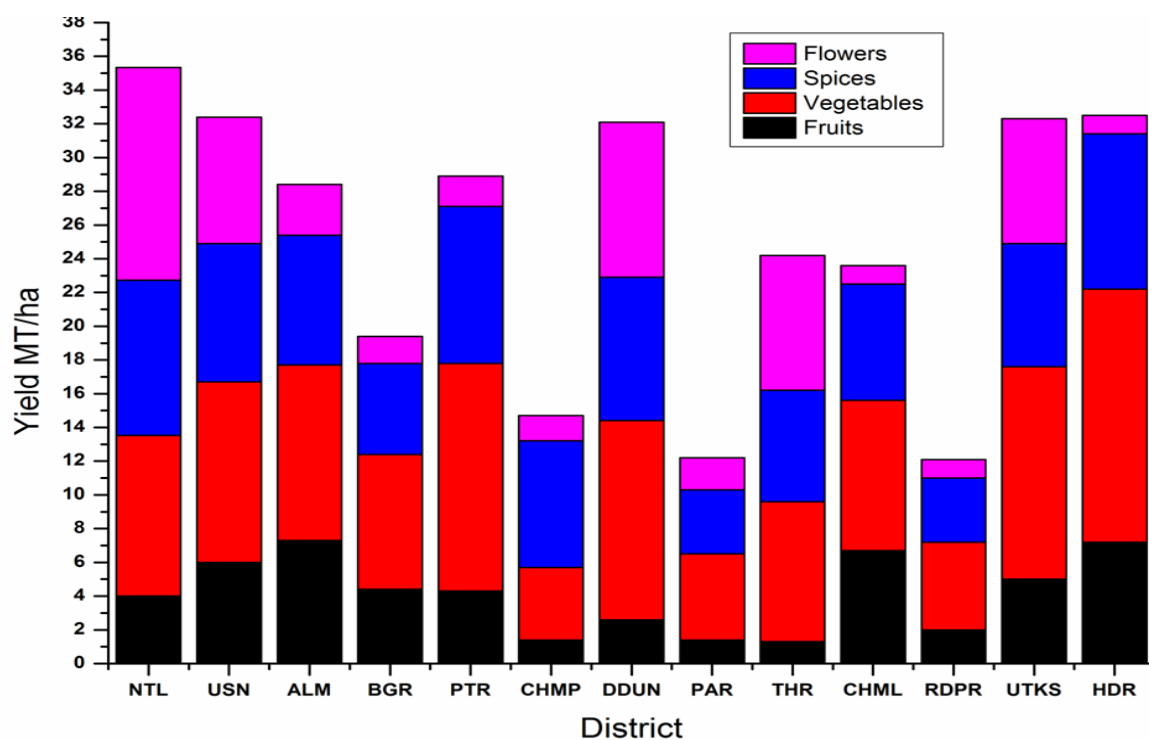


Figure 1. Yield MT/ha of horticultural crops, 2013-14 in districts of Uttarakhand

Abbr.: NTL = Nainital; ALM = Almora; BGR = Bageshwar; PTR = Pithoragarh; CHMP = Champawat; DDUN = Dehradun; PAR = Pauri; THR = Tehri; CHML = Chamoli; RDPR = Rudraprayag; UTKS = Uttarkashi and HDR = Hardwar

Table 7. Change in area under horticultural crops

Horticultural crops	2001		2014		Change (%) 2001-2014
	Area (ha)	% share of horticultural area	Area	% share of horticultural area	
Fruits	190192	63.6	230901	64.2	+21.4
Vegetables	102407	34.3	117267	32.7	+14.5
Spices	6067	2	9650	2.7	+59.1
Flowers	278	0.1	1292	0.4	+364.7
Uttarakhand	298944	100	359110	100	+21.1
India*	16.6 (million ha)	-	20.9 (million ha)	-	+25.9

Source: Tour report of horticulture commissioner on his visit to Uttarakhand in 2015; *Indian horticultural database, National Horticultural Board, Gurgaon 2014

Table 8. Change in production of horticultural crops

Horticultural crops	2001		2014		Change (%) 2001-2014
	Production (MT)	% share of horticultural production	Production (MT)	% share of horticultural production	
Fruits	345339	26.1	723554	40.4	+109
Vegetables	941281	71.3	996517	55.7	+5.9
Spices	33614	2.5	68576	3.8	+104
Flowers	324	0.1	1041	0.1	+221
Uttarakhand	1320558	100	1789688	100	+35.5
India*	145.8 (million ton)	-	223.1 (million ton)	-	+53

Source: Tour report of horticulture commissioner on his visit to Uttarakhand in 2015; *Indian horticultural database, National Horticultural Board, Gurgaon 2014

4. Progress in Horticultural Farming

To obtain progress in horticultural farming, we gathered time series data – 2001 and 2014 and observed change (%) in area, production and yield of all horticultural crops – fruits, vegetables, spices and flowers (Table 7). The highest area is shared by fruits in both years which is 63.6% in 2001 and 64.2% in 2014. Vegetables follow it in both years – 34.3% in 2001 and 32.7% in 2014. Spices and flowers obtain very less area. We observed changes in all horticultural crops in a decade. Average increase in area of horticultural crops is 21.1%. Flowers obtain the highest increase *i.e.* 364.7% followed by spices 59.1%. 21.4% increase in area under fruits was observed while area under vegetables increases 14.5%. In India, 25.9% increase in area under horticultural crop was noticed during the years. Production share of vegetables is the highest in both years which is 71.3% in 2001 and 55.7% in 2014. It is followed by fruits 26.1% and 40.4% in both years, respectively. Spices share 2.5% production in 2001 and 3.8% in 2010. Flowers production is very low in both years (0.1%). We observed 35.5% increases in production of all vegetables. Out of it, flowers received 221% increase; it was followed by fruits (109%) and spices (104%). Production of vegetables increases only 5.9% (Table 8). During the same time, production of horticultural crops increased by 53% in

India. Table 9 shows changes in yield of horticultural crops. The highest yield was observed in vegetables which are 9.2 and 8.5 in 2001 and 2014 respectively. It is followed by spices 5.5 and 7.1 respectively. Fruits obtain third place in yield and flowers have the lowest yield. In terms of increase in yield during the corresponding years, it is the highest of fruits (72.2%) followed by spices (29.1%). There is a decrease of 33.3% in flowers and 7.6% in vegetables. Average increase in yield of horticultural crops is 13.6%. India obtained 21.6% increase in yield of crops during the same period.

Table 9. Change in yield of horticultural crops

Horticultural crops	Yield (MT/ha)		Change in % 2001-2014
	2001	2014	
Fruits	1.8	3.1	+72.2
Vegetables	9.2	8.5	-7.6
Spices	5.5	7.1	+29.1
Flowers	1.2	0.8	-33.3
Uttarakhand	4.4	5	+13.6
India*	8.8 (MT/ha)	10.7 (MT/ha)	+21.6

Source: Tour report of horticulture commissioner on his visit to Uttarakhand in 2015; *Indian horticultural database, National Horticultural Board, Gurgaon 2014

Discussion and Conclusion

Uttarakhand grows a number of horticultural crops. We listed here 11 fruit crops, 10 vegetable crops, six spices and five flowers although, there are many other horticultural crops including medicinal plants grow. We analyzed them and observed that the crops, which have the highest area have low yield. Suppose, mango, apple and citrus have the highest area (average 16.9% each) they have comparatively low yield which is about 4.2 Mt/ha average. In contrast pear, peach and guava have comparatively less area (7.5%, 4.4% and 0.7%) yield is high (6.3 MT/ha). In area, production and yield of vegetables, we also observed that higher the percentage share of area, lower is the crops yield. Green pea has the highest area and production (18.22% and 14.33% respectively), yield is only 7.77 MT/ha. Contrary to it, cauliflowers shares 4.15% area and 5.6% production, its yield is 13.31 MT/ha. Similarly, onion obtains 6.15% area and 6.26% production, its yield is 10.05. The same implies with other crops. In spices, we did not observe any particular pattern. The highest share of area and production is obtained by ginger (41.09% and 57.38%), its yield is also high (10.1). In contrast, yield of chili was observed only 3.7 MT/ha while it shares 20.7% area. It is similar with coriander (14.6% area and 4.8 yields) and garlic (12.5% area and 6.67 yields). In turmeric, area share is less 7.9%, its yield is slightly higher i.e. 8.33. We established relationship between area and yield of flowers and noted that higher the area, lower is the yield and vice versa. The highest area is shared by marigold (43.6%) while its yield is only 1.5 MT/ha.

Similarly, gladiolus shares 29.1% area yield is only 1.8%. Area under rose is also high (10.9%) while yield is only 1. Meanwhile, carnation shares only 2.2% area and its yield is 19 and gerbera has 5.6% area and its yield is 46.2. We analyzed all horticultural crops in terms of their yield and noticed that vegetable crops have the highest yield (9.88 MT/ha) and a number of districts fall under very high level of yield. Fruits and vegetables have the high crop diversity. Progress in horticulture crops in respect of area, production and yield (2001-2014) reveals that although spices and flowers have the lowest area, yet change in their area is the highest. Fruits and vegetables have the highest area share; increase in area is comparatively less (average increase is 17.5%). Although, vegetables have the highest yield, yet increase in its production is very less (5.9%). The highest increase was noted in flowers while its yield is very less. In spite of increase in area and production during the last decade, yield of vegetables and flowers decreased. Our findings show that horticulture farming has very high potential in the sustainable development of rural

Uttarakhand. Uttarakhand is bestowed with feasible agro-climate where a number of horticulture crops grow. Landscape also supports its cultivation with high production and yield. Keeping all the characteristics in mind, we suggest some measure to promote horticultural farming that can increase economy and augment employment. Nainital, USN, Dehradun, Tehri and Uttarkashi districts have high yield of flowers thus these district can grow flowers largely. Spices can grow in Nainital, USN, Almora, Pithoragarh, Champawat, Dehradun, Uttarkashi and Hardwar districts as yield of spices is very high in these districts. Farming of vegetables is suitable in USN, Almora, Pithoragarh, Dehradun, Uttarkashi, Hardwar, Nainital, Bageshwar, Tehri and Chamoli districts and fruits can grow in Almora, Hardwar, Uttarkashi, Chamoli and USN. Finally, we suggest the districts which are suitable for growing various horticultural crops are Nainital, USN, Dehradun, Hardwar (all plain districts), and Uttarkashi, Pithoragarh, Almora, Tehri and Chamoli (hill districts). Further, crops can grow according to agro-climatic zones. Mango, guava and papaya can grow in subtropical climate zone. Farming of citrus crops is suitable in the valleys and mid-altitudes. Apple, pear, peach, walnut, apricot and plum are suitable in the temperate zone. Temperate region of Uttarakhand has potential to grow various fruits; we can divide the whole temperate region into fruit belts. In vegetables, potato can grow in the high latitudes, onion in the mid-altitudes and tomato in the valleys. Ginger is a suitable crop to grow in both subtropical and temperate zones. Flowers can also grow in all altitudinal zones. The region can attain sustainability in horticultural farming, if these suggestive measures are adopted.

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