



The Typology and Agro-climatic Zones of Fruit Cultivation in Uttarakhand Himalaya

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ABSTRACT

The Uttarakhand Himalaya has a rich agro-climate for cultivating various kinds of fruits at different altitudes. Four agro-climatic zones – plain regions and the river valleys (sub-tropical), lower-middle zone (sub-tropical), upper-middle zone (temperate), and the highlands (temperate and cold) comprised it. This paper examines the typology, potential, and development of fruit cultivation in the Uttarakhand Himalaya. Data were gathered from secondary sources - the Directorate of Horticulture and Food Processing, Horticulture Bhawan, Chaubatiya, Uttarakhand. Further, the participatory approach was applied to validate the area, production, and productivity of fruits after rapid field visits to fruit-growing areas. Based on the above-mentioned agro-climatic conditions, fruit types and fruit growing areas were correlated as temperate fruits (apple and pear) in the highlands, nut and stone fruits in the middle and high altitudes, citrus fruits in the valley regions, and sub-tropical fruits (mango, guava, and litchi) in the valley and the plain regions. The area and production of the principal fruits were gathered and the productivity of the fruits was noticed. The author has categorized fruit cultivating areas into three zones according to the agro-climate and the area, production, and productivity of fruits. These zones are named developed, developing, and potentials. The present study is original. It presents new findings in the fields of fruit cultivation in the Uttarakhand Himalaya. If intensive fruit cultivation is carried out by providing all the infrastructural facilities including market facilities, it will enhance the income and livelihoods of the rural people.

1. Introduction

Fruits are rich sources of nutrients and vitamins and are very essential components of daily food intake. They are equally contributing toward medicinal and aesthetic values. Apart from these merits, the economic value of fruits is enormous, once the trees start producing fruits (Kumar and Mruthyunjaya 2002). Fruit cultivation has the potential to enhance opportunities for smallholders in coping with poverty through increasing income and employment (Joshi et al. 2006). Although, the area under fruit cultivation is comparatively less than the area devoted to crops and vegetables worldwide yet substantial diversity in fruit crops and an increase in arable land under fruit cultivation have manifested increasing income and employment in the recent past (Vyas 1996; Joshi; 2005; Birthal et al. 2007; Kashish and Dhawan 2017).

India is witnessing the launch of several programmes for the development of fruit cultivation (Singh and Toppo 2010). The diverse climate has ensured the availability of all varieties of fresh fruits in India. As a result, it has become the world's largest producer of Banana, mango, and citrus (Banarjee 2009) and ranks second in fruit cultivation after China. India has 6.38 million ha of land under fruits which is 11.9% of the total fruit area in the world (55.1 million ha). In terms of production, India produces 74.9 million tonnes of fruits, which is 12.5% of the world's fruit production (599.3 million tonnes). The productivity of fruits in India is 11.7 t/ha while at the world level, the productivity of fruits is 10.9 t/ha (Ministry of Statistics and Programme Implementation 2011). In the Uttarakhand Himalaya, the productivity of fruits is 36.8 t/ha, which is just three times much more than India and the world.

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The horticulture sector is one of the emerging and potential sectors, which contributes 30% to Gross Domestic Products (GDP) in India. On the other hand, development of the fruit cultivation plays a greater role in providing sufficient nutrition and income to the farmers including the marginal farmers (Swarup et al. 1987). During the last decades, the annual compound growth rate of fruits grew to 5.3% in India (Sharma and Jain 2011). Further, the productivity of horticultural crops has increased only marginally from 7.5 t/ha in 1991-92 to 8.4 t/ha in 2004-05 (NHB 2005). In the Himalayan states of India, the production of apples has increased substantially however the productivity has fallen from 10.8 to 5.8 t/ha (Awasthi et al. 2001). Moreover, the investment in cultivating fruits has transformed the agrarian economy in many states of India, during the ninth and the 10th plan periods (Singh, 2008).

The Himalayan region, stretching from Jammu and Kashmir in the northwest to Himachal Pradesh and Uttarakhand in the central part and Sikkim and Arunachal Pradesh in the east, obtains suitable agro-climatic conditions for cultivating varieties of fruits in different altitudinal zones. Mainly the temperate fruits – apple types and nut fruits are grown abundantly in the Himalayan states. The Uttarakhand Himalaya, one of the integral parts of the Himalaya, known as the 'Indian Central Himalayan Region' (ICHR), occupies the central place in cultivating fruits. A large part of the population (about 70%) lives in the rural areas of the Uttarakhand Himalaya and it depends on agriculture for carrying livelihood sustainably however the landholdings are small and fragmented and irrigation facilities are limited (Mittal et al. 2008).

Fruit cultivation is quite suitable in the ecologically fragile terrain of the Uttarakhand Himalaya. Suitable agro-climate, altitudinal variations, and slope aspects are the major drivers for sustainable fruit cultivation. The cold climate in the highlands supports for high production of apples. The hot winds (Loo) blow in the Tarai and Bhabhar regions of the state improving the quality of mango. High rainfall during the monsoon season and humid climate throughout the year further provide a base for fruit cultivation in the Uttarakhand Himalaya. Fruit cultivation has multiple implications mainly on the economy and environment. On the one hand, it enhances the income and economy as it is an economically viable crop, it restores the degraded land and environment on the other hand (Sati 2004, 2005, 2018). Fruit cultivation also plays a vital role in sustaining the livelihood of the rural people. The researchers and academicians observed that the cultivation of fruits has a high potential to improve nutrition, attain food security, generate income and augment employment (Tewari 1987; ICAR, 2005; Rai and Yadav 2005). Diversification of fruits and their optimal cultivation is a pathway to harnessing suitable agro-climate of the

Uttarakhand Himalaya (Brithal et al. 2006). Also, the market is an essential force to develop horticultural farming (Vishwanadham 2006).

Despite rich agro-climatic conditions, diversity in fruits, and a suitable landscape for the development of fruit cultivation, the Uttarakhand Himalaya could not attain an impressive position. The area and production of fruits are quite less than the area and production of food grains and vegetables. Further, due to changes in agro-climatic conditions, the production and productivity of fruits have decreased, which has led to the abandonment of fruit cultivation areas. The areas, which were suitable for cultivating fruits at different altitudes, are now vanished and some of them have moved to higher altitudes. Although, several studies were conducted on the development of horticultural farming in the Uttarakhand Himalaya, yet, the present theme, mainly typology and potential of fruit cultivation, has not been addressed adequately so far. This study is an attempt to address all these issues for the first time. A research question 'how to harness the suitable and rich agro-climate of the region for sustainable horticultural development was raised and answered in this paper. Based on the research question, the major objective of this paper examines the typology, potential, and development of fruit cultivation in the Uttarakhand Himalaya. It further analyses the area, production, and productivity of fruits and suggests the sustainable development of fruit cultivation that can enhance the income and livelihoods of the rural people of Uttarakhand through revisiting agro-climatic zones under the influence of climate variability and change.

The Area

The Uttarakhand Himalaya comprises two distinct geographical and socio-cultural entities known as the Garhwal Himalaya and the Kumaon Himalaya. Further, the Garhwal Himalaya comprises seven districts – five mountainous districts – Chamoli, Pauri, Rudrapur, Tehri, and Uttarkashi; the Dehradun district has both plain and mountainous areas and Haridwar is a fully plain district. Similarly, the Kumaon Himalaya has six districts – four districts are mountainous, which are Pithoragarh, Champawat, Bageshwar, and Almora; the Nainital district is partially plain and Udham Singh Nagar (USN) is a fully plain district. Therefore, there are a total of nine mountainous districts, two districts are partially mountainous, and two districts are fully plain. The Kumaon Himalaya is located in the east part of the Garhwal Himalaya, bordered by Nepal from the east, Tibet (China) from the north, and Uttar Pradesh from the south. The Garhwal Himalaya, in the west part of Uttarakhand, is delimited by Uttar Pradesh from the south, Himachal Pradesh from the west, and Tibet (China) from the north.



Figure 1. Location map of the Uttarakhand Himalaya showing fruit typology

The total geographical area of Uttarakhand is 53,483 sq km. Out of which, 93% area is the mountainous mainland (Figure 1). About 16% area of the mountain region is snow-clad. The area under fruit cultivation is only 1805 sq km, which is 3.37% of the total geographical area of the Uttarakhand Himalaya. The climate ranges from sub-tropical in the plain regions and the river valleys to temperate in the middle altitudes, cold in the highlands and alpine pasturelands, and frigid cold in the snow-clad mountain peaks. Temperature ranges from 0° to 40° C whereas the average annual rainfall is 1200 mm. It supports the growth of several fruit cultivars/species accordingly. The landscape of the Kumaon Himalaya is comparatively gentle and consequently, the arable land is fertile, which has a significant impact on the production and the productivity of fruits, although the area under fruit cultivation is less in the Kumaon Himalaya (1.34%) than to its counterpart the Garhwal Himalaya (2.03%).

2. Methodology

This study was conducted using both qualitative and quantitative methods. Data were gathered from the handbook (2018-19) of the Directorate of Horticulture and Food Processing, Horticulture Bhawan, Chaubatiya, Uttarakhand. The area and production of the principal fruits – apple, pear, peach, plum, apricot, walnut, citrus fruits, mango, litchi, guava, and Amla (Indian gooseberry) were collected from 2018-19 data at the state and district levels. The state has a total of 13 districts – seven districts of the Garhwal

Himalaya and six districts of the Kumaon Himalaya. The author visited many fruit-growing areas of the Uttarakhand Himalaya. He used participatory appraisal to validate the area and production of crops. The data were analyzed using statistical methods. The fruits were categorized into four typologies – temperate fruits (apple and pear), nut fruits (walnut, peach, plum, and apricot) citrus fruits (Lemon, orange, mandarin, elephant citrus, kino, Amla), and tropical (Mango, Litchi, and Guava) according to the altitudes and agro-climatic conditions. The area and production of all types of fruits were summed up and based on the area and production of fruits, the productivity was calculated. Data were analyzed using maximum, minimum, mean values, and standard deviation. The area, production, and productivity of fruits were indices and then levels – high, medium, and low were given to each fruit type at the district level. Apart from it, data on the area, production, and productivity at the state and district level were also shown using graphs and a map. A diagram was constructed to represent agro-climatic zones and fruit types. Based on the levels of the area, production, and productivity of each fruit type, the Uttarakhand Himalaya was divided into three fruit cultivation zones – developed, developing, and potential, and a district-wise description of each zone was given.

3. Results

The Area and Production of Fruits

Figure 2 shows the area and production of fruits in the Kumaon and Garhwal Himalayas. The total area under

fruit cultivation in the Kumaon Himalaya is 71,681 ha, whereas the area under fruits in the Garhwal Himalaya is 108,789. It means that the Garhwal Himalaya has 51.76% much more area than the Kumaon Himalaya. Meanwhile, in terms of production, the Kumaon Himalaya has 415,301 MT, while it is 249,353 MT in the Garhwal Himalaya, which shows that the Kumaon Himalaya has 39.95% more production than the Garhwal Himalaya. As a result, the productivity of fruits in the Kumaon Himalaya is quite high (5.79 MT/ha) with the highest in Nainital (9.92 MT/ha) and the lowest in Pithoragarh (2.99 MT/ha). In the Garhwal Himalaya, the productivity of fruits is 2.29 MT/ha with the highest in the Rudraprayag and Haridwar (6.27 MT/ha in each district) and the lowest in the Tehri district (1.37 MT/ha). The overall productivity of fruits in Uttarakhand is 3.68 MT/ha.

District-wise Area, Production, and Productivity of Crops

Table 1 (Figure 3) depicts the levels of the area, production, and productivity of fruits in Uttarakhand. The districts of Uttarakhand were leveled as high, medium, and low according to the area, production, and productivity of fruits. The total area under fruit cultivation in Uttarakhand is 180,470 ha. Out of which, Dehradun, Almora, Pauri, and Tehri districts have a high level (>10%) area. The districts, which come under medium level in the area (5-10%), are Pithoragarh, Haridwar, Uttarkashi, and Nainital. Five districts – Champawat, USN, Chamoli, Bageshwar, and Rudraprayag have <5% area and they come under a low level.

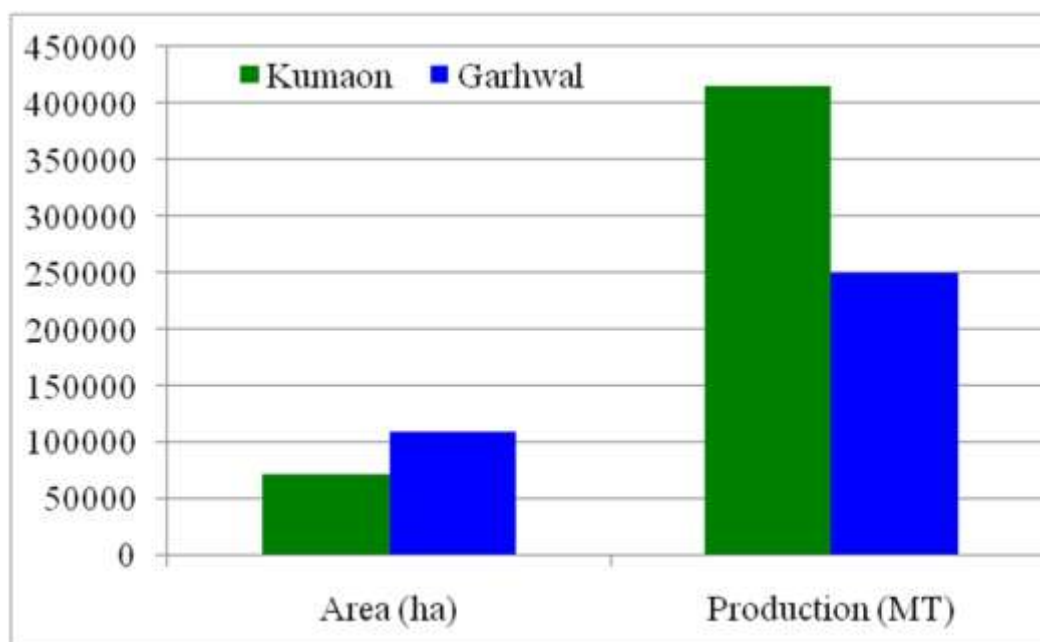


Figure 2. Area and production of all fruits in Kumaon and Garhwal regions

Table 1. District-wise area, production, and productivity of fruits

Area (% of total state area 180470 ha)		
Level	Indices	Districts
High	>10	Dehradun, Almora, Pauri, and Tehri
Medium	5-10	Pithoragarh, Haridwar, Uttarkashi, and Nainital
Low	<5	Champawat, USN, Chamoli, Bageshwar, and Rudraprayag
Production (% of total state production 664654 MT)		
High	>10	Almora, Nainital, Haridwar, and USN
Medium	5-10	Pithoragarh, Dehradun, and Pauri
Low	<5	Tehri, Uttarkashi, Champawat, Chamoli, Bageshwar, and Rudraprayag
Productivity (MT/hastate average 3.68)		
High	>6	Nainital, Almora, USN, Rudraprayag, and Haridwar
Medium	3-6	Champawat, Bageshwar, and Chamoli
Low	<3	Pithoragarh, Uttarkashi, Pauri, Dehradun, and Tehri

The total production of fruits in Uttarakhand is 664,654 MT of which, >10% is obtained by Almora, Nainital, Haridwar, and USN districts. Three districts – Pithoragarh, Dehradun, and Pauri have medium-level production (5-10%). Low production of fruits (<5%) is obtained in Tehri, Uttarkashi, Champawat, Chamoli, Bageshwar, and Rudraprayag districts. Based on the area and production, the productivity of fruits was analyzed. Five districts – Nainital, Almora, USN, Rudraprayag, and Haridwar have a high level of productivity, which is >6 MT/ha. Medium level of productivity (3-6 MT/ha) of fruits is obtained by three districts – Champawat, Bageshwar, and Chamoli, and low productivity (<3 MT/ha) is obtained by Pithoragarh, Uttarkashi, Pauri, Dehradun, and Tehri districts. The average productivity of fruits is 3.68 MT/ha.

Productivity of Various Fruits

The productivity of fruits (MT/ha) was analyzed (Figure 4). It was noticed that the Kumaon Himalaya has the highest average productivity of fruits (5.3 MT/ha) than the Garhwal Himalaya (2.9 MT/ha). The Uttarakhand Himalaya has an average of 3.8 MT/ha productivity. In Kumaon, the productivity of peach and pear is the highest (<9 MT/ha), followed by plum (6.1 MT/ha) and mango, apricot, and apple (5-6 MT/ha). The other fruits have less than 5 MT/ha productivity. In Garhwal, peach has the highest productivity (9.7 MT/ha), followed by Guava (4.8 MT/ha). The other fruits have less than 4 MT/ha productivity. The average productivity of fruits is 2.9 MT/ha. In Uttarakhand as a whole, the highest productivity is obtained by peach (7.1 MT/ha), followed by pear (5.9 MT/ha), and guava 5.1 MT/ha. Mango, Citrus, and Plum have <4 MT/ha productivity. The other fruits have also <4 MT/ha productivity.

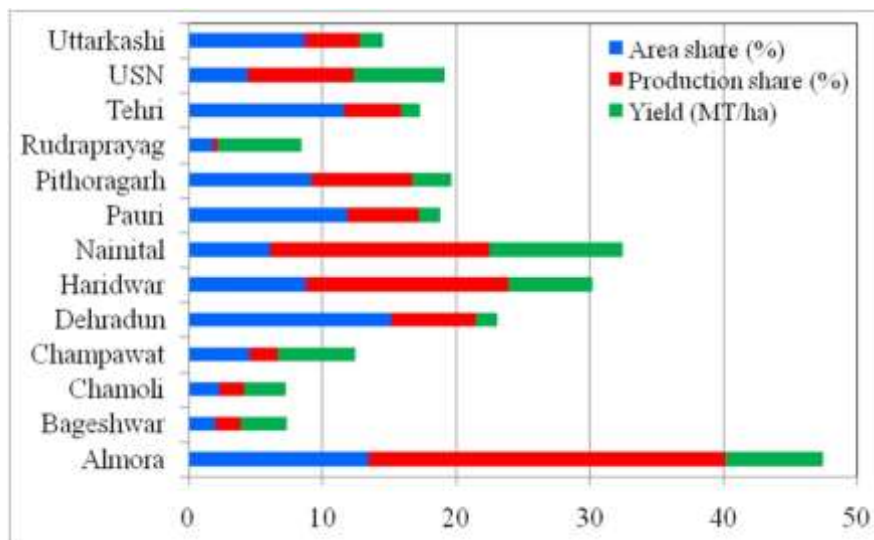


Figure 3. District-wise area, production, and productivity of fruits

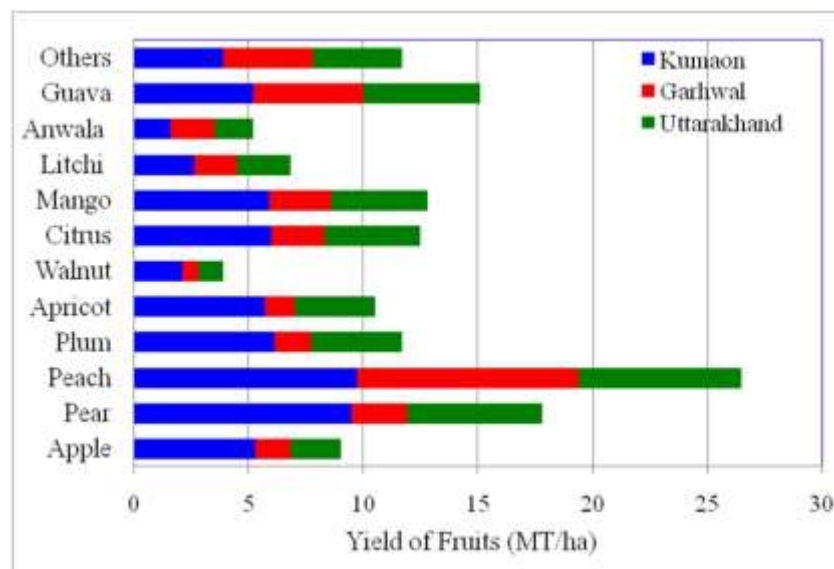


Figure 4. Productivity of various fruits in Kumaon, Garhwal, and Uttarakhand

Descriptive Statistical: Area, Production, and Productivity

Descriptive statistics of the area, production, and productivity of the principal fruits were analyzed (Table 2). The mean value of the area is the highest in tropical fruits (4082.63 ha), followed by nut fruits (3575.42 ha), and temperate fruits (2989.62 ha). The lowest mean value of the area is noticed in citrus fruits (1662.15 ha). Similarly, the production is the highest of Mango type fruits (15424.38 MT), followed by nut fruits (12918.36 MT), and temperate fruits (10385.15). Citrus fruits have 6994.15 MT/ha mean values. In terms of productivity, citrus fruits have the highest mean value (4.14 MT/ha), followed by tropical fruits with 3.16 MT/ha, and temperate fruits (3.05 MT/ha). Nut fruits have the lowest productivity (2.48 MT/ha mean values).

Fruit Typology and Agro-climatic Zones

Fruit typology was analyzed based on the fruit cultivars/races of the same genera that grow in a specific agro-climatic zone, fruit typology was categorized as temperate fruits, nut fruits, citrus fruits, and tropical fruits. The fruits that grow under each typology, agro-climatic zones, and the districts where these fruits grow, are described largely (Table 3).

Temperate Fruits

Temperate fruits include apples and pears. The Uttarakhand Himalaya has a suitable agro-climate to grow temperate fruits. It grows in the temperate (cool) agro-climatic zone, which lies at >1800 m altitudes. Since most human habitation is limited up to 2,400 m altitude, therefore, the upper limit of growing apple and pear fruits is 2400 m altitude. The highest productivity of temperate fruits is obtained in three districts – Almora, Nainital, and Pithoragarh, which are the developed zones. It is followed by Chamoli, Pauri, and Champawat districts, which have a developing nature. The other districts have registered less productivity, which has the potential to grow temperate fruits.

Nut and Stone Fruits

Nut fruits include peach, plum, apricot, and walnut that grow between 1100 m and 2000 m altitudes in the temperate and the sub-tropical agro-climatic zones. Nainital and Almora districts have developed nature to grow nut fruits, followed by Chamoli and Bageshwar districts, which have developing nature. The other districts – Pithoragarh, Uttarkashi, Dehradun, Champawat, Pauri, Tehri, and Rudraprayag have the potential for cultivating nut fruits.

Citrus Fruits

Lemon, orange, mandarin, elephant citrus, and kino are the major types of citrus fruits that grow in the entire Uttarakhand Himalaya. These fruits grow in the sub-tropical zone, which stretches between 500 m and 1100 m altitudes. Almora, USN, Nainital, Bageshwar, Pithoragarh, and Chamoli districts have a high potential for cultivating citrus fruits. However, in Haridwar, Uttarkashi, and Pauri districts, the cultivation of citrus fruits is in developing nature. The other four districts – Champawat, Tehri, Dehradun, and Rudraprayag have the potential to grow citrus fruits.

Tropical Fruits

The main fruits that grow under tropical fruits are mango, litchi, and guava. Tropical fruits grow mainly in the river valleys and plain regions in the sub-tropical climate zone, which lies mainly >500 m. The *Tarai* region of Nainital district, USN, river valleys of Almora district, and Haridwar district grow tropical fruits largely. Tehri, Bageshwar, Pauri, and Chamoli districts have the developing nature to grow tropical fruit. The other five districts – Uttarkashi, Dehradun, Champawat, Pithoragarh, and Rudraprayag have the potential to grow tropical fruits.

Table 2. Area of fruits (ha), n=13 districts

Typology	Minimum	Maximum	Mean	Std. Deviation
Temperate fruits	68	10849	2989.62	3158.86
Nut fruits	175	9402	3575.42	2969.46
Citrus fruits	242	4369	1662.15	1307.80
Tropical fruits	305	10639	4082.63	3153.62
Production of fruits (MT/ha), n=13				
Typology	Minimum	Maximum	Mean	Std. Deviation
Temperate fruits	437	49871	10385.17	13593.41
Nut fruits	443	67494	12918.36	20597.42
Citrus fruits	808	33725	6994.15	9345.07
Tropical fruits	273	47616	15424.38	16863.58
Productivity of fruits (MT/ha), n=13				
Typology	Minimum	Maximum	Mean	Std. Deviation
Temperate fruits	0	10	3.05	3.32

Nut fruits	0	12	2.48	3.46
Citrus fruits	1	8	4.14	2.49
Tropical fruits	1	9	3.16	2.39

Table 3. Fruit typology, agro-climatic regions, and fruit growing districts

Typology	Principal fruits	Agro-climatic zones (Altitude m)	Growing districts		
			Developed	Potential	Progressive
Temperate fruits	Apple and pear	Temperate cool (1800-2400 m)	Almora, Nainital, and Pithoragarh	Chamoli, Pauri, and Champawat	Bageshwar, Uttarkashi, Dehradun, Tehri, and Rudraprayag
Nut and stone fruits	Peach, Plum, Apricot, and Walnut	Temperate and sub-tropical (1100-2000 m)	Nainital and Almora	Chamoli and Bageshwar	Pithoragarh, Uttarkashi, Dehradun, Champawat, Pauri, Tehri, and Rudraprayag
Citrus fruits	Lemon, orange, mandarin, elephant citrus, and kino	Sub-tropical (500-1100)	Almora, USN, Nainital, Bageshwar, Pithoragarh, and Chamoli	Haridwar, Uttarkashi, and Pauri	Champawat, Tehri, Dehradun, and Rudraprayag
Tropical fruits	Mango, Litchi, Guava, and Amla	Sub-tropical and tropical (<500m)	Nainital, USN, Almora, and Haridwar	Tehri, Bageshwar, Pauri, and Chamoli	Uttarkashi, Dehradun, Champawat, Pithoragarh, and Rudraprayag

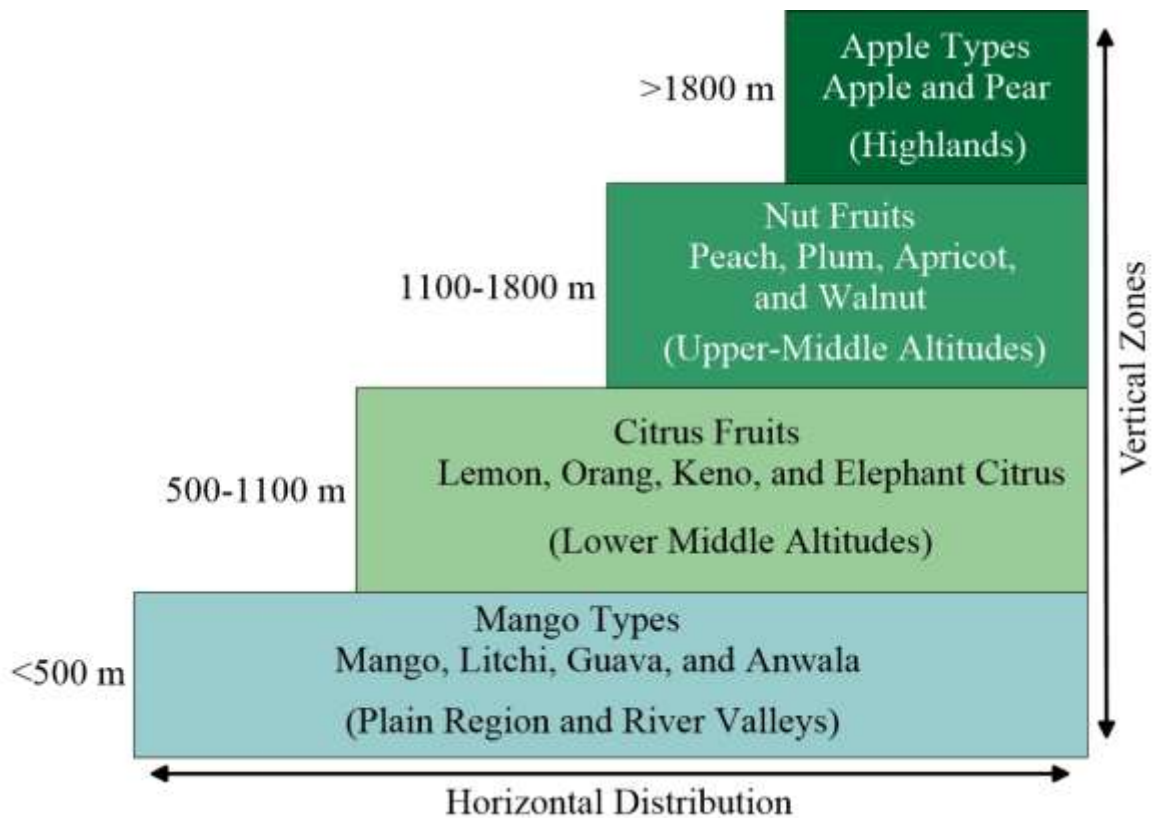


Figure 5. Graphic representation of fruit typology and agro-climatic zones

Figure 5 shows the agro-climatic zones, which are suitable for growing various types of fruits. Fruits grow mainly in the sub-tropical and temperate climate ranges from <500 m to >1800 m altitudes. The plain region and the river valleys grow tropical fruits, which include mango, litchi, guava, and amla. This zone lies <500 m altitude. Citrus fruits are grown between 500 m and 1100 m altitude in the sub-tropical climate zone (lower-middle altitudes). Varieties of fruits are grown in this zone. The upper-middle altitudes grow nut fruits, which lie between 1100 m and 1800 m altitudes in the temperate zone. The last zone is temperate and cold zones lie in the highlands >1800 m altitudes. This zone is very suitable for growing apple and pear fruits.

Horizontal Zonation of Fruit Cultivation

Data on the area, production, and productivity of fruits – apple types, nut and stone fruits, citrus fruits, and mango types were analyzed by summing up them at the district level. The districts were given ranks based on their performances and then they were scored. Finally, the districts were divided into three categories – developed, developing, and potential zones (Figure 6).

Developed Fruit Zone

The developed fruit zone comprises Nainital, Almora, Chamoli, and Bageshwar districts. In these districts, the area, production, and productivity of fruits are quite high. The area under fruits in these districts is >10% of the total area under fruits. Similarly, the production of fruits is also >10%. The productivity of fruits in these districts is >6 MT/ha. All types of fruits grow in these districts from the river valleys to the highlands, however, the area, production,

and productivity of the fruits vary from one location to another. Nainital district comprises both plain and mountain areas, whereas Almora, Chamoli, and Bageshwar are fully mountainous districts.

Developing Fruit Zone

A large part of the Uttarakhand Himalaya comprises developing zones in terms of fruit cultivation. The major districts comprising developing zones for fruit cultivation are Pithoragarh, Pauri, Uttarkashi, USN, Champawat, Tehri, and Dehradun. USN is a plain district, where mango is grown largely. Litchi is grown in the plain part of the Dehradun district. Nut and citrus fruits are grown in the mountainous parts of the Dehradun district. Pithoragarh, Pauri, Uttarkashi, Champawat, and Tehri districts grow apple, nut, and citrus fruits. The area under fruit crops in this zone is 5-10% of the total fruit area; the production is between 5 and 10% of the total production. The productivity of the fruit crop is 3-6 MT/ha.

Potential Fruit Zone

The potential fruit zone has the areas of <5% under fruits, production of <5%, and the productivity of <3 MT/ha. The potential fruit zone comprises Haridwar and Rudraprayag districts. Haridwar is a plain district where mango-type fruits are grown largely. The district has the largest area under mango fruit. Rudraprayag district has a small proportion of land for apple and pear fruits. Citrus is also grown in the Rudraprayag district. Meanwhile, the area, production, and productivity of fruits are comparatively less. Therefore, these two districts have potential fruit zones.



Figure 6. Horticultural zonation of fruit cultivation

4. Discussion

The Uttarakhand Himalaya has the high potential to grow all kinds of fruits along all the altitudinal gradients from the plain region to the river valleys, middle altitudes, and the highlands because of the suitable agro-climatic conditions. The two distinct geo-cultural regions of the Uttarakhand Himalaya – the Kumaon Himalaya and the Garhwal Himalaya have different capacities to grow fruits. Although the area under fruit crops is less in the Kumaon Himalaya, the production is higher than in the Garhwal Himalaya because of its suitable geo-environmental conditions. The slope is gentle and the arable land is fertile. Altitudes play a significant role in determining the diversity and types of fruit crops. Apple and pear need a cool climate; therefore, they had higher performance in the districts, which are mountainous with a temperate and cold climate. The area, production, and productivity of fruits are also high in the higher altitudes. In the meantime, the area, production, and productivity of mango-type fruits such as litchi, guava, mango, and amla are high in the plain areas and the river valleys. Citrus fruits are grown at altitudes from 500 m to 1100 m largely because of a comparatively warm climate. Nut fruits are grown between 1100 m and 2000 m, which lie in the higher-middle altitudes and the highlands.

It has been noticed that the area under different fruits is high in the district, which has the maximum area in the middle altitudes. The plain districts and the highly mountainous districts have less area under fruit crops. The landscape in the mountainous mainland is rugged and precipitous. Most of the land is either forested, stony barren land, or snow-clad, while the arable area is quite less. Further, a large arable land is devoted for the cultivation of food grains, pulses, oilseeds, and vegetables therefore area under fruit cultivation is less. In the plain district, arable land is fertile, where agricultural practices are carried out largely, and thus, the area under fruit cultivation is less. In terms of production, it is higher mostly in the plain districts (because of the fertile land), followed by the districts, which are located in the middle altitudes (because of more human power). Therefore, the productivity of fruit crops was noticed high in plain districts. It means that the plain district has less area under fruit crops however, the production is higher.

Some fruit crops have high productivity such as peach, pear, guava, mango, and citrus. These crops grow in different districts and at different altitudes. It has been noticed that the productivity of almost all fruit crops is higher in the Kumaon Himalaya than in the Garhwal Himalaya, which reveals the future potential to grow fruits in the Kumaon Himalaya enormous. Citrus fruits have a high potential to be grown in the entire region, as the productivity of citrus fruits is high, although, the area under its cultivation is less. Meanwhile, the productivity of nut fruits is less,

although the area under its crop is comparatively high. The author observed that the production of nut fruits has decreased in the recent past. Apple and mango fruits have substantial productivity, although the area under apple fruits is less. In a nutshell, fruit diversity is high in the entire Uttarakhand Himalaya because of the diverse climatic conditions.

The author observed the reasons for the less area as well as the less productivity of fruit crops in Uttarakhand Himalaya. The arable land is already limited, which is about 18% of the total geographical area. Further, the farmers do not willing to transfer more arable land for fruit cultivation because of the long juvenility of fruit trees. The farmers are marginal and poor. They cannot wait for five years to get the output of crops. It is also not sure whether the fruit crops will grow substantially after five years. The market is another problem, the marginal farmers are facing. After getting a substantial fruit crop, they did not find an appropriate market and therefore they could not get the price at the input level. Those farmers, who transferred their land for cultivating fruits in the decade of 1970s, reused the land for cultivating crops and as a result, the area under fruit crops is less, which was noticed about 60%.

The second important reason for the less area under fruit cultivation is high variability and change in the climate. The author has observed that the river valleys and the middle altitudes, which were suitable for the cultivation of citrus, nut, and stone fruits, faced high climate variability and as a result, the cultivation of citrus, nut, and stone fruits has completely vanished from these locations. Similarly, the areas where apples and pears were grown earlier have been shifted towards the higher altitudes, which are uninhabited areas. Cultivation of other fruits is facing a similar problem. All these reasons have led the marginal farmers not to practice fruit cultivation largely in the Uttarakhand Himalaya. It has been noticed that the agro-climatic conditions of the Uttarakhand Himalaya are suitable for cultivating varieties of fruits. If the cultivation of fruits is carried out sustainably, the Uttarakhand Himalaya can attain an impressive position.

5. Conclusion

This study reveals that the Uttarakhand Himalaya has a high potential to grow several kinds of fruits in different altitudinal zones. The agro-climate is quite suitable and it is varied according to the altitudes. Three prominent zones of fruit cultivation – developed, developing, and potential – have significant future potential. Mostly the mountainous districts are the developed zones, where all types of fruits grow even tropical fruits in the river valleys. The USN and Haridwar districts grow tropical fruits because of the hot climate and fertile land. However, the area under fruit cultivation is less in the entire Uttarakhand Himalaya, and

therefore, the output from fruit crops is less. An acre of arable land can be devoted to the cultivation of fruits. There is a need to revisit the agro-climatic regions given climate variability and change. The suitability of fruit crops according to the agro-climate can be delineated. Market facilities can be ensured so that the marginal farmers can get their returns. This study reveals that intensive fruit cultivation, mainly in the developed fruit zones, can enhance the income and economy and can attain a sustainable livelihood status.

6. References

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