



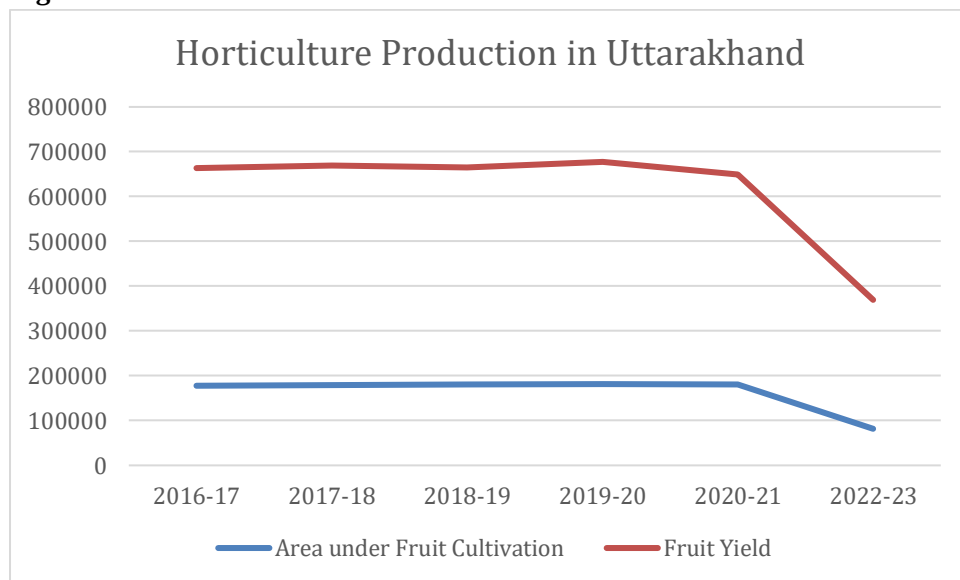
Changing Horticultural Production in Uttarakhand under Conditions of Global Warming: An Analysis

Introduction

Horticulture is an important economic sector in Uttarakhand contributing significantly to our national fruit basket. The mountains, lush green valleys and undulating plains of the state with their diverse climatic conditions are ideal for the production of both temperate and sub-tropical fruits.

Once a [leading producer](#) of pear, peach, plum, and apricot and the [third largest producer](#) of high quality apples in the country, the yield of major fruit crops have plummeted significantly in the state in the last seven years. The decline in yield and area under cultivation of major fruits have been stark since 2020. The dip is particularly remarkable for temperate fruits as compared to their tropical counterparts. Changing temperature patterns in the state could partially explain the shifting horticultural production in the state. With warming climate rendering certain fruit varieties less productive, farmers are shifting towards tropical alternatives which are better attuned to the altering climatic conditions.

Figure 1: Trend in Horticulture Production in Uttarakhand between 2016-17 and 2022-23



Source: Department of Horticulture, Government of Uttarakhand

Table 1: Decline in Area under cultivation and yield of all types of fruit crops in Uttarakhand

	2016-17	2022-23	% decline
Total Area under fruit cultivation in hectares	177323.5	81692.58	54
Total Yield of Fruits in Metric Tonnes	662847.11	369447.3	44

Table 2: Percentage Change in Fruit Production in Uttarakhand between 2016-17 and 2022-23

Fruits	% change in area under cultivation	%change in yield
Pear	-71.61	-74.10
Apricot	-71.17	-69.01
Plum	-70.49	-65.18
Walnut	-67.29	-52.69
Apple	-55.05	-30.18
Lemon Variety	-53.03	-58.48
Litchi	-49.78	-20.62
Mango	-42.20	-24.46
Peach	-30.48	-37.61
Goose Berry	-23.49	63.77
Guava	36.63	94.89

Source: Department of Horticulture, Government of Uttarakhand

Trend in Production of Major Fruits in Uttarakhand between 2016-17 and 2022-23

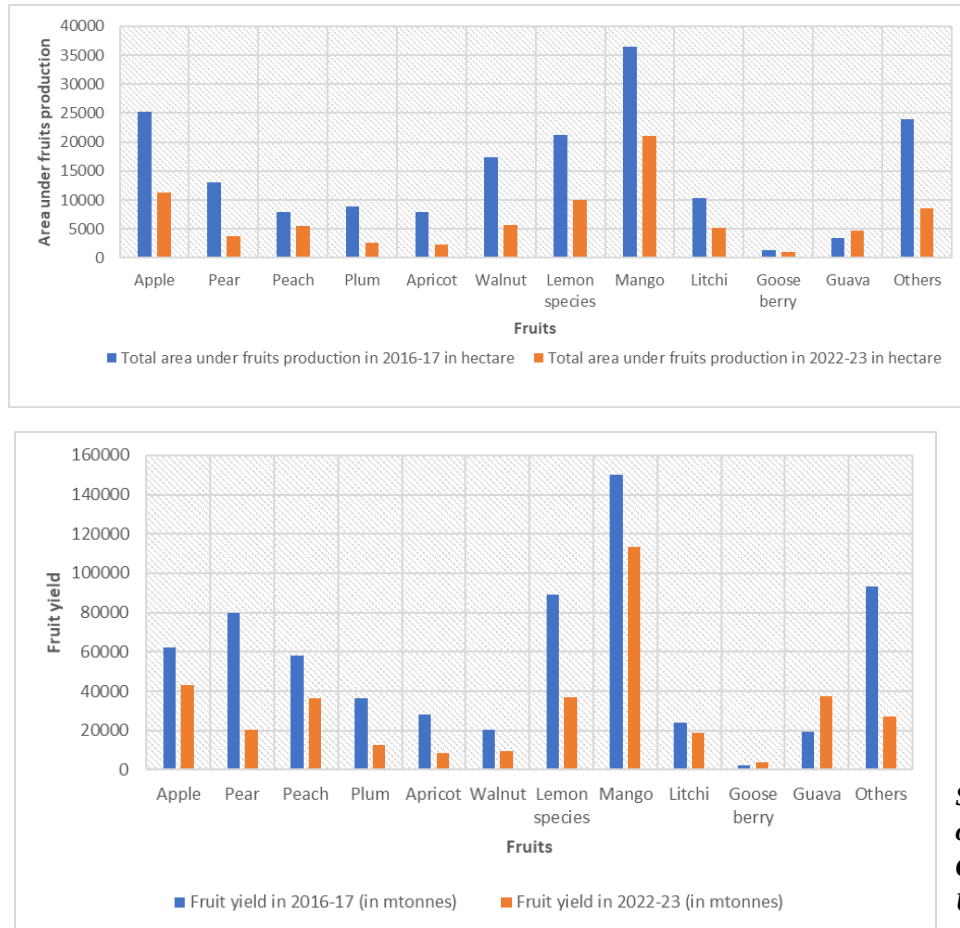
Uttarakhand has witnessed a massive shrinkage in the area under horticulture production which also coincides with the declining yields of major fruit crops in the state. Cultivated in the higher altitudes of the Himalayas temperate fruits like pear, apricot, plum and walnut have seen the maximum fall in production. Apples and lemons have been moderately hit. The area under apple production reduced from 25,201.58 hectares in 2016-17 to 11,327.33 hectares in 2022-23 with a corresponding 30 percent decline in yield. The yield of lemon varieties shrunk by 58 percent. Tropical fruits were less affected.

Despite nearly 49 and 42 percent reduction in cultivation area, production of mango and litchi remained relatively stable, with slight declines of 20 and 24 percents respectively. Conversely, guava showed a notable increase of 36.64% in production area from 3,432.67 hectares in 2016-17 to 4,690.32 hectares in 2022-23. Gooseberry and guava showed significant rises in yield marked by 63.77% and 94.89%, respectively, indicating positive trends for these fruits during the same time frame.

The variations in fruit production area in Uttarakhand between 2016-17 and 2022-23 reveal striking shifts in cultivation patterns across different fruit types. Substantial reductions in certain fruit varieties over the past seven-years suggest changes in agricultural strategies, land allocation, market dynamics,

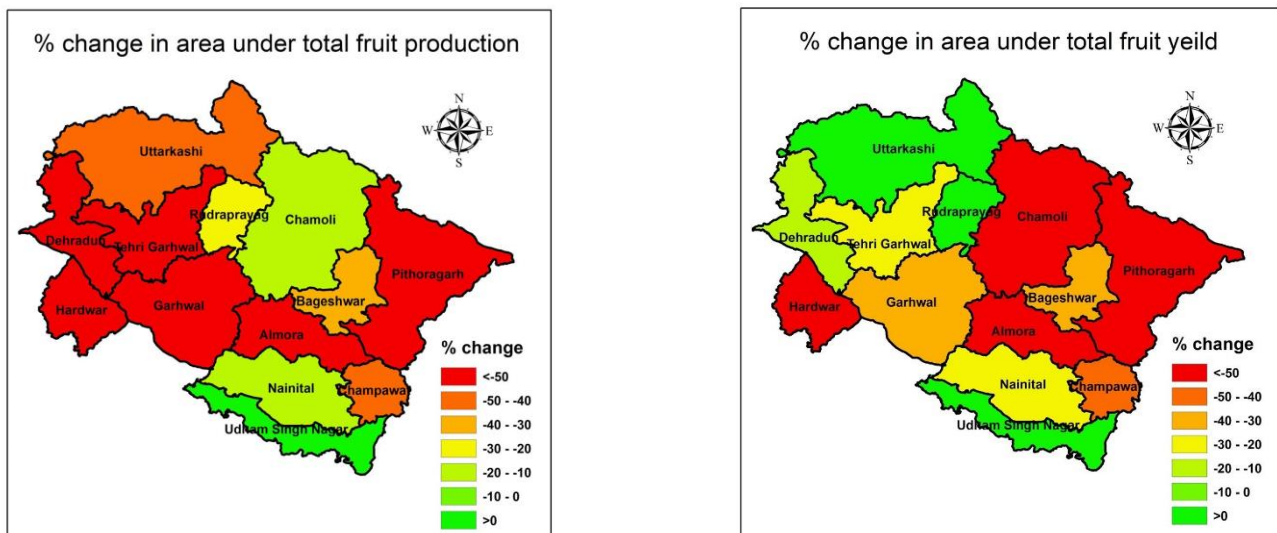
and possibly environmental influences affecting specific fruits. The increase in production of guava and gooseberry, indicates a shift in focus towards fruit types that are better attuned to market demand or local conditions.

Figure 2 & 3: Percentage change in Area and Yield of Major Fruit Crops between 2016 and 2022-23



Source: Department of Horticulture, Government of Uttarakhand

Figure 4 & 5: District Level Variation in Area and Yield of Major Fruit Crops between 2016-17 and 2022-23



Source: Department of Horticulture, Government of Uttarakhand

Shrinking Area under Fruit Production: District wise Analysis

Table 3: District Wise Variation in Area and Yield of Major Fruit Crops between 2016-17 and 2022-23

Districts	% change in area	% change in yield
Tehri	-75.61	-24.77
Dehradun	-68.68	-19.75
Almora	-66.85	-83.88
Pithoragarh	-63.65	-66.24
Haridwar	-57.33	-64.57
Pauri	-56.49	-35.71
Champawat	-49.77	-41.30
Uttarkashi	-42.94	26.50
Bageswar	-32.56	-39.25
Rudraprayag	-28.14	11.73
Chamoli	-13.33	-52.94
Nainital	-11.27	-20.75
Udhamsingh Nagar	5.03	18.38

Source: Department of Horticulture, State of Uttarakhand

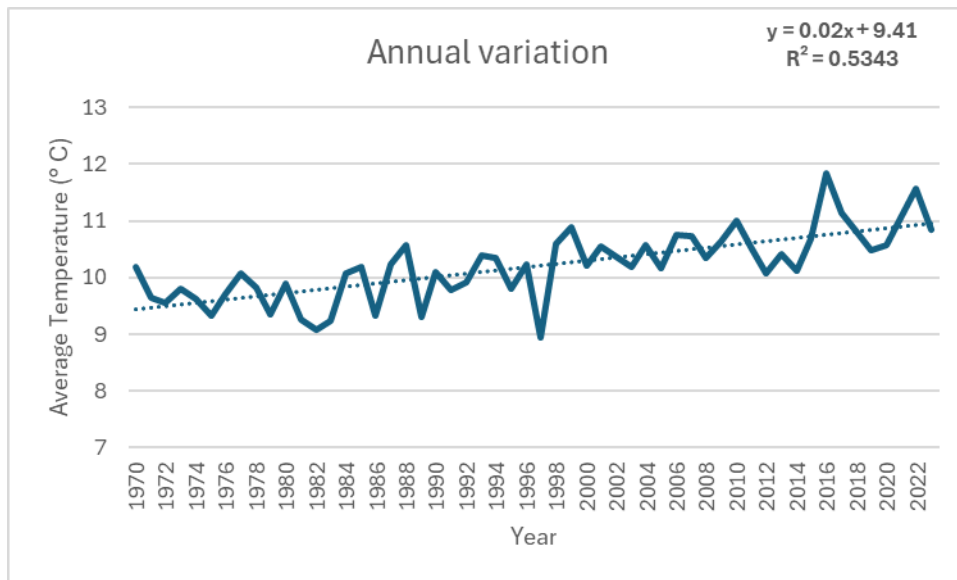
Tehri registered the maximum decline in area under cultivation followed by Dehradun. The corresponding fall in yield however was not particularly significant in both the districts. Almora, Pithoragarh and Haridwar on the other hand recorded notable reductions in both areas under cultivation and fruit yields. Fruit production in Almora reduced by 84 percent, the highest among all districts. Despite only 13 percent shrinkage in area under production between 2016-17 and 2022-23, fruit yield diminished disproportionately by nearly 53 percent in Chamoli. Uttarkashi and Rudra Prayag on the contrary saw 26.5, 11.7 percent rise in yield despite nearly 43 and 28 percent decline in area under cultivation.

Impact of Warming on Horticulture Production

Warming can partly explain these profound changes in horticulture production. Shifts in temperature patterns directly impact fruit growth, development, and overall productivity. Higher temperatures can also pose challenges such as heat stress, reduced water availability, and altered precipitation patterns,

negatively affecting yields. Additionally, changing temperature regimes can influence the prevalence and distribution of pests and diseases in fruits, necessitating adaptation through pest management strategies.

Figure 6: Temperature Trend in Uttarakhand between 1970 and 2022



Source: Climate Central

Warm and Dry Winters Affect the Production of Temperate Fruits

Average temperature in Uttarakhand increased at an annual rate of 0.02 degrees Celsius between 1970 and 2022. The state recorded approximately 1.5-degree Celsius warming over the same period with higher elevations experiencing amplified rates of warming.

[Research](#) reveals that relatively warmer winter temperatures in the higher altitudes have accelerated snow melt triggering a rapid decline in snow cover areas. In the past 20 years, winter temperatures at high elevations of the state have increased at the rate of [0.12°C/decade](#). Precipitation has fallen by 11.2 mm per decade resulting in a rapid shrinking of Snow Cover Area at the rate of [-58.3 km² /decade](#). In Uttarkashi, Chamoli, Pithoragarh, Rudra Prayag districts Snow Cover Areas have shrunk by nearly [90-100 km²](#) in 2020 as compared to 2000.

Winter chill and snow are the prerequisites for the growth and flowering of fruits like apple, plum, peach, apricot, pear, walnuts, grown in higher altitudes of the Himalayas. While higher temperature in the upper altitudes of the Himalayas is melting snow covers, lack of precipitation in early winter months is preventing fresh snow accumulation depriving temperate fruit trees of their requisite chilling hours thereby, altering the flowering time.

Chilling Requirement of Winter Fruits

During winters, temperate trees enter the phase of dormancy when growth is halted to avoid cell damage from low temperatures. Exposure to extreme cold, understood as “chilling requirement” is necessary for such trees to come out of dormancy and initiate bud formation, blooming, and fruit inception.



Exceptionally warm winters, less snowfall, shrinking snow cover area may have caused abnormal pattern of bud-break and subsequently reduced flowering and yields of temperate fruits.

“Traditional temperate crops like high quality apples have a chilling requirement of less than 7 degrees Celsius for 1200-1600 hours during the period of dormancy (Dec-March). Apples require 2-3 times more snowfall than what the region received in the last 5-10 years leading to poor quality and yield.” explained **Dr Pankaj Nautiyal, Head & Senior Scientist, Horticulture, ICAR-CSSRI, Krishi Vigyan Kendra.**

“Barish aur barf kaam hone se bahut hi dikkat ho rahi hain (Lack of winter snow and rain is posing a major hurdle in fruit production),” mentioned **Mohan Chaubatia, a farmer from Ranikhet.** He further added that production of temperate fruits has reduced to half in the last two decades in Almora. Farmers who cannot afford irrigation have been the worst affected due to the increasingly dry winters and low fruit productivity in the state.

Uttarakhand has also been in the eye of recurring disasters ranging from extreme rainfall events, flooding, hailstorms and landslides resulting in significant damages to agricultural fields and standing crops. In 2023, [44,882](#) hectares of farm lands were lost to extreme weather events. Dwindling agricultural prospects have also led to widespread [out migration](#) from the hills to the plains which could also explain the shrinking area under horticultural production.

Warming Favours Tropical Fruit Cultivation

While warmer temperatures hinder the growth of winter fruits, farmers are shifting to tropical alternatives. In some districts of Uttarakhand farmers are choosing low chilling cultivars of apples or replacing hard nut fruits like plum, peach, and apricots with tropical alternatives like [kiwi and pomegranate](#). In fact, there has also been an experimentation with [high density cultivation](#) of amrapali mango in the lower hills and valleys of Uttarkashi district which generated high returns for farmers.

The Way Forward

The declining horticulture production in the state of Uttarakhand paints a dull future of a once thriving industry. **Dr Subash Nataraja, Head, Division of Agricultural Physics, ICAR-IARI, New Delhi** expressed that *“The short-term variability and trends in temperature are worrying and there is a need to study the long-term trends in weather variables and its relation to yield, especially, its relation with any change in crop/cropping pattern or shift in crop/cropping pattern.*

With changing climatic conditions rendering the production of temperate fruits less viable, the state is on the verge of losing its rich diversity of fruit varieties. It is therefore necessary to shift towards climate resilient practices to safeguard the horticulture sector from future risks. **Dr Nataraja** further suggested that *“there is a need to identify/develop location specific climate resilient varieties and management practices to reduce the impact of climate change and climate variability. Moreover, climate financing is very much essential to save the farming community from adverse weather aberrations. Another point is we need to advocate the village level agromet advisory services and its dissemination to various stakeholder in a timely manner, so that they can prepare against adverse situations and make decisions accordingly.”*

