

Impact of Climate Change on the Apple Economy of Himachal Pradesh: A Case Study of Kotgarh Village

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Abstract. *In Himachal Pradesh agro-climatic conditions are suitable for the cultivation of variety of fruit crops. The development of these crops has greatly fulfilled the needs and objectives of socio-economic growth in the state. Among various fruit crops grown in the state apple dominate in area as well as production. Himachal Pradesh is the second largest producer of apple in India. But due to environmental change some areas are experiencing decline in the productivity of apple in the state. The present study is an attempt to analyze the changes in the growth of apple orchards in terms of space and time in response to changing environment. The study will be based on primary as well as secondary data.*

One time Himachal Pradesh was known for best quality apple in the country but now in many parts of the state apple has become uneconomical, nonviable, less profitable and even unproductive. Over the years, fruit growers in the study area have observed significant variations in climate. This awareness of climate change is based mainly on the associated impacts on the apple crop especially on blossoming, fruit setting, yield and increased incidences of pests and diseases. Over all the climate is described as being much warmer and people perceive a definite reduction in snowfall over time. Not only has the actual amount of snowfall decreased but changes in timing of snowfall have also been noticed. Snowfall in December and January has become rare and the period of snowfall now extends through the months of February-March. As a result to maintain an apple orchard has been become an uphill task. New trees simply don't survive and older ones are dying fast and the farmers have switched over to other fruits and vegetables.

Key words – Climate Change, Apple, economy, snowfall, temperature, rainfall

I. Introduction

Climate change is already a reality for a majority of Indian farmers even as plans are being evolved at the government level mostly to create adaptive capabilities; meanwhile, Indian farmers are being forced to adapt to several climate change related changes by themselves because they have no other choice. For no fault of theirs, Indian farmers are paying a high price for anthropogenic climate change.

The worst-hit, as usual, are small and marginal holders in marginalized locations with social disadvantages to begin with. Such farmers have meager resources to buffer them from the new risks that climate change poses. It is reported that about two-thirds of the sown area in the country is drought-prone and around 40 million hectares is flood-prone. The poorest people are likely to be hardest hit by the impacts of climate variability and change because they rely heavily on climate-sensitive sectors such as rain fed agriculture and fisheries. They also tend

to be located geographically in more exposed or marginal areas, such as flood plains or nutrient-poor soils. The poor are less able to respond due to limited human, institutional and financial capacity and have very limited ability to cope with climate impacts and to adapt to a changing hazard burden.

In the post independence era, horticultural crops emerged as an important source of earning livelihood for small and marginal farmers. Its role in the country's nutritional security, poverty alleviation and employment generation programmes is becoming increasingly important. It not only offers wide range of options to farmers for crop diversification, but also provides ample scope for sustaining large number of Agro-industries which generate huge employment opportunities. Presently horticulture is contributing 24.5 percent of GDP from 8.5 percent land area. Horticultural development was not accorded a place of priority in various development plans in the initial years of planned development. During the period 1948-80, the main focus of development plans was on cereals and horticulture sector was never at the forefront. It was in the post-1993 period that a due attention was given to horticulture development through an enhancement of plan allocation and knowledge-based technology. National Horticulture Mission was launched in 2005-06 by the Government of India with a mandate to promote integrated development in horticulture. As a result, in past one and a half decade, the changes in cropping pattern are more biased towards horticulture sector. Due to this change in cropping pattern, an increase in horticultural produce has been observed, and India has become the second largest producer of fruits and vegetables in the world, next only to China. Last decade was called a "golden revolution" in horticultural production because of exceptional achievements in the field.

TABLE. 1

STATE WISE AREA AND PRODUCTION OF APPLE (2007-08)

State/UT	Area (000'HA)	Production (000' MT)
Jammu & Kashmir	126.4	1268.5
Himachal Pradesh	94.5	592.6
Uttrakhand	32.2	130.5
Arunachal Pradesh	10.8	9.8
Nagaland	0.04	0.5
Total	263.9	2001.5

Source: National Horticulture Board

Climate change is a big challenge for horticulture producers in the country. Among different horticultural crops apple is highly vulnerable to climate change because apple is the most important temperate fruit grown in the temperate region of the country which lies in the Himalaya and Himalayan region is warming at a rate which is 5-6 times more than the global average. Apple cultivation is not only most remunerative as compared to field crops, but is also labour- intensive and thus helps in absorbing ever-growing problem of unemployment. This fruit is grown in the hilly states of India.

Apple is the fourth major fruit crop of the country in terms of production after Mango, citrus fruits and banana. It occupies an area of 263.9 thousand hectares with a production of 2001.5 thousand metric tones (table 1). It is grown mainly in the states of Jammu and Kashmir, Himachal Pradesh, Uttrakhand and Arunachal Pradesh. Share of total area and production of apple in the total production during 2007-08 was 4.8 and 3.4 percent, respectively. While total area under apple is the highest in Jammu and Kashmir and it occupies second place in Himachal Pradesh.

Himachal Pradesh is known for the production of quality apples. The state has agro- climatic and geographical conditions favorable for apple cultivation. Apple cultivation in Himachal Pradesh started in 19th century. The credit of discovering the immense potentialities of growing apple fruits in the state goes to the American and European missionaries. The first apple orchard in the 19th century was established at Bundrole in Kullu tehsil by Capt. R.C. Lee. This fruit occupied only 10 percent (134 ha) of the total area under fruits in 1951, which was confined to a few pockets namely Mahasu, Kullu, Mandi etc. from where it diffused to other parts of the state [4]. State made rapid strides in the production of apple in post independence period. It covered an area of 26735 hectare during 1970-71 which increased to 97209 hectare in 2008-09.

TABLE 2

HIMACHAL PRADESH: AREA, PRODUCTION AND PRODUCTIVITY OF APPLES

Year	Area (Ha)	Production (MT)	Productivity (MT/HA)
1970-71	26735	103120	3.9
1980-81	43331	118013	2.7
1990-91	62828	342071	5.4
2000-01	92820	376736	4.1
2008-09	97209	510161	5.2

Source: Directorate of Horticulture, Shimla, H.P.

There was a penta fold increase in apple production during the time period 1970-71 to 2008-09 (Table 2). As far as productivity is concerned, Himachal Pradesh does not enjoy a good position. It has noticed an increase of only 1.3 metric tones per hectares during the period under reference. Kangra, Solan, Sirmaur and Chamba have recorded decline in the productivity of apple during last three decades.

Due to increasing average temperatures and decline in snowfall, apple trees are not able to survive or are becoming unproductive. Apple belt of the state is shifting towards the higher reaches. Large areas that were earlier suitable for apple cultivation have now been rendered unfit for the same. Farmers of the affected areas are changing their cropping patterns and diverting their lands to other cash crops like tomatoes, peach and peas in order to sustain their farm income. According to [5] the data available on temperature in Himalayas indicate that warming during last 3-4 decades has been more than the global average of 0.75% over the last century. Himalayas are warming at a pace which is 5-6 times more than the global average. Temperature increases are more during winter and autumns than during summers, and they clearly increase with altitudinal rise.

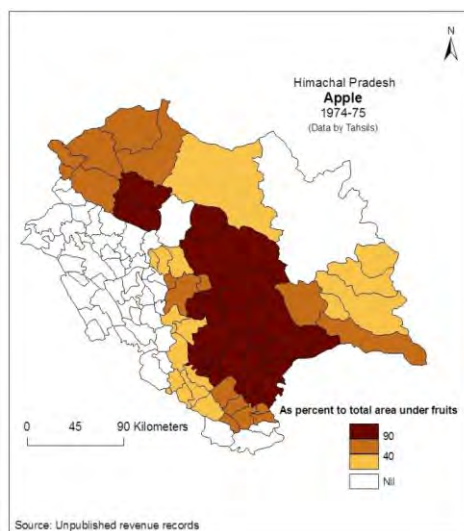


Fig. 1. Spatial Spread of Apple during 1974-75

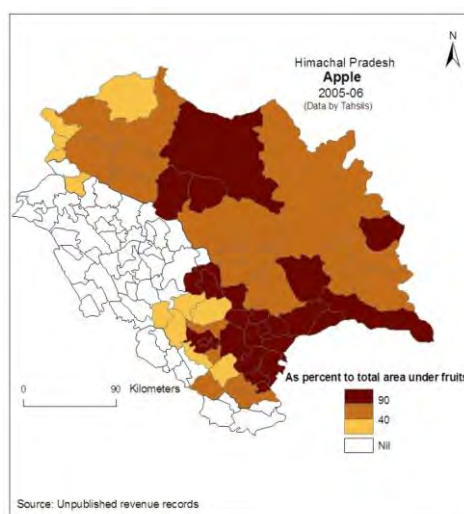


Fig. 2. Spatial Spread of Apple during 2005-06

According to a report of [2] the air temperature in the state is one degree centigrade higher than in the year 1970. The average temperature of Shimla has increased by about 1°C during last 100 years. The average snowfall in the state decreased from 272.4 cm in the year 1976-80 to 77.20 cm in the year 2001-04. According to horticulturists of the state, global warming has caused loss of vigour, fruit bearing ability, reduction in size of fruit, less juice content, low colour, reduced shelf life and increasing attacks of pests resulting in the low production and poor quality crop

It is evident from Figs. 1 and 2, that 9 tehsils, namely, Padhar, Sundernagar and Jogindernagar of Mandi district, Bajjnath tehsil in Kangra district, Bilaspur Sadar of Bilaspur district, Krishangarh, Solan and Kasauli tehsils of Solan district and Dadahu in Sirmaur district had 0.1 to 40 percent of the total fruit area under apple during 1974-75 and during 1974 to 2006, there was a gradual decline in area under apple cultivation. As a result, by the end of the study period, i.e. in 2005-06, area under apple orchards practically diminished in these nine tehsils. Similarly three tehsils of Mandi district Aut, Mandi and

Kotli were major apple producing areas of the state where 40 to 90 percent of the total fruit area was devoted to apple cultivation in 1974-75, but afterwards due to increase in temperature and decrease in snowfall these areas experienced sharp decline in area under apple cultivation and at the end of the study period share of these tehsils was almost negligible in apple production of the state. On the other hand as mentioned in [7] Lahaul & Spiti and Kinnaur districts which lie in Cold and Dry zone have noticed remarkable increase in area under apple between 1974-2006 which is attributable to the development in the infrastructural facilities and the climatic conditions which have become hospitable for the cultivation of apples during the period under reference .

II. Study Area

Kotgarh is a village in Kumharsain tehsil of Shimla district in Himachal Pradesh. It is located between 31° 19' 0" North, 77° 29' 0" East. It is situated 82 km from Shimla on the old Hindustan-Tibet road.

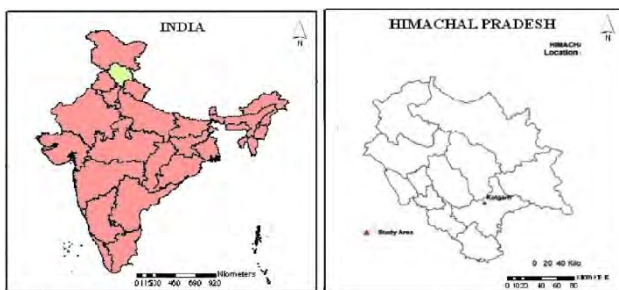


Fig.3 Location of the Study Area

Located about 6,500 feet above sea level, it was famous for its apples and acres of apple orchards. Kotgarh is just 16 kilometers from National highway that heads into the valley through Kumarsain, Rampur and Kinnaur. Climatically, Kotgarh is located in the temperate region of the state. Kotgarh was earlier known as Sebgarh because of high quality apples that were grown here. At present, Kotgarh is experiencing decline in apple production.

III. Significance of the Study

During past couple of decades, the study area has faced a strange phenomenon. Farmers in Kotgarh have had to abandon apple farming due to certain climatic changes that eventually made it unsuitable to grow apples. This change has consequently led to a continuous upward shift of the apple belt towards the north. This study takes the apple as an indicator crop to investigate the negative effect of climate change on spatial spread of apple orchards and farm economy. It explores the impact it had on the apple economy of the farmers of hilly state who were forced to give up apple farming.

IV. Objectives

I. To Study the Spatial-Temporal Variability of Apple orchards in Kotgarh Village.

II. To analyze the impact of climate change on apple orchards and apple economy in the study area.

III. To investigate other associated factors affecting the apple production in the study area.

V. Data Base and Methodology

The study is based on primary as well as secondary data

Primary data

The most important source of information for this study is farmers as they are the ones who have been experiencing the strongest effects of climate change on apple. For this purpose, a structured questionnaire was prepared including questions on all relevant aspects of information necessary for this study. Twenty four farmers (11 marginal, 8 small and 5 large farmers from Kotgarh) were selected with the help of multistage stratified sampling technique. To know the changes in climate in the area, some questions related to changes in temperature and precipitation over the last 30 to 40 years were included in the climate change awareness baseline study. This is very important to know the farmers perception about climate change. These questions were asked specifically to those villagers above 40 years of age. The aim of this approach was to obtain a clear picture with respect to changes in these two key parameters of climate change.

Secondary Data

Data related to area and production of apple in the country has been collected from the horticulture data base published by National Horticulture Board. To know the changes in area, production and productivity of apple in Himachal Pradesh unpublished data of directorate of Horticulture, H.P, Shimla has been used. To analyze the spatial-temporal changes of apple orchards in the state, data of unpublished revenue records of Directorate of Land Records, H.P. Shimla has been collected at tehsil level for two time periods i.e. 1974-75 and 2005-06.

To ascertain if warming is actually taking place in the region, getting data on temperature and precipitation for at least last 30 years was accorded the top priority. Source of this climatic data is website of India water portal. Unfortunately climatic data for Kotgarh as a unit was not available so the data of Shimla district as a whole has been analyzed to see the changes in temperature and precipitation. Landuse data of Kotgarh village has been collected from the office of patwaar circle Kotgarh. This data is also not satisfactory. According to lal kitaab, there is no change in land-use land-cover after 1970 but after analyzing the primary data it is found that area under apple orchards has decreased significantly during last four decades.

Primary data was largely analyzed using simple mathematical methods (percentage and averages) and partially using statistical techniques. Choropleth maps were prepared in GIS environment to know the spatial changes in area under apple in the state. Bar and line graphs have been prepared to analyze the climatic data.

VI. Results and Discussion

Kotgarh was once known as the ‘apple bowl of India’ because of production of large volumes of quality apples. This village had the highest per capita income in Asia because of highly remunerative apple economy. Sour quality of apples namely King pipen and Ras pipen had a long history in Kotgarh. These were wild varieties of apple grown in the village before the introduction of delicious varieties of apple by Samuel Nicholas Stokes in 1918.

The Kotgarh was known as “Sebgarh”, and had the privilege of being honored with the “first Udyan Pundit” award in 1959 for best apple orchards in Himachal Pradesh. The remarkable success of fruit trees here is attributed to the fact that the subsoil is well drained and aerated thus facilitating deep root penetration. Besides the backward and poor locale were available as cheap labourers to work in orchards and transport the fruits manually or on the back of mules, due to the absence of transport facilities in these areas. These considerations tempted the foreigners to settle down in these hill areas and take to fruit growing [4]. According to Balokhra [1] the credit of discovering the immense potentiality of growing apple in the study area as well as in Himachal Pradesh goes to Satyanand Stokes who came to Kotgarh as a Christian missionary in the early 20th century. He fell in love with Kotgarh so much that it became his *Karma Bhumi*. He married to a local village girl and raised a family. Stokes turned to the Upanishads and eventually converted to Hinduism. The few plants of plums, pears and apples which Stokes brought with him from America in 1916 were planted around his house Harmony Hall in Barobag. These plants became the source that motivated him to explore a suitable cash crop for the hills. Back in Philadelphia, Stokes’ mother, Florence Spencer Stokes helped him in developing the apple orchard by following the advancement of new cultivators in American nurseries. The “Royal Delicious”, a new variety developed and planted by the reputed Stark Brothers Nursery at Louisiana was imported in 1921. The consignment arrived in early December, at a time when Stokes was imprisoned in Lahore jail. Along with this consignment, the “Golden Delicious” variety arrived as a gift from Florence Stokes to her son. These saplings were planted by Stokes’ wife. Today, Golden Delicious apples grown in Kinnaur are among the finest apples produced in the world. Kotgarh became the cradle from where the apple revolution spread to other regions of the state and turned Himachal into leading apple producing state of India. During 1920s, apple orchards in the study area bore fruits and the economy started growing very fast. The first consignment of apple from Kotgarh marketed to Shimla in 1921. Majority of people in Kotgarh started apple cultivation before 1940s and every land parcel which was suitable for cultivation was brought under apple orchards.

According to the old farmers of the village, commercialization of apple plants in the village started in late 1920s; they developed their own nurseries and sold the plants to the neighboring villages and other parts of the state at a cost of 7 silver coins for one plant of apple.

So the farmers started earning money from the sale of fruits as well as from nursery which made them unbelievably rich. Satyanand Stokes opened a School named Tara High School in 1940 after the name of his son. In this school students were taught about the cultivation of apples. Local people also got training in this school regarding apple cultivation.

During 1930-1980, there was a boom in apple production in the study area. But in succeeding decades, Kotgarh started experiencing a wind of change. According to a respondent, in 1970-71, there was 6 feet snowfall in the area and many trees collapsed due to heavy snow fall. After 1970s, snowfall started declining but it was enough for chilling of apples. In 1980-81 the area received a little more than 2 feet snowfall. But after 1980s a sharp dip in amount of snowfall was noticed. Decline in snowfall led to a decline in apple production.

As per the revenue records of village, 100 percent of the agricultural land is under apple orchards and is dominated by small and marginal farmers.

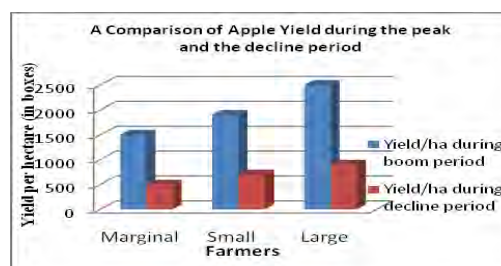


Fig. 3 Yield during the peak and the decline period

An analysis of primary data reveals that 100 percent of the sampled farmers experienced a decline both in productivity and area under apple orchards. They observed a decline of 2/3 in productivity as compared to the peak period (Fig 3). According to a respondent, they used to get 40 to 50 boxes from a fully grown apple tree during the peak period but now it has reduced to 8 to 9 boxes. Small and marginal farmers are most vulnerable to this change. They have small land holdings and small sized farms and not able to sustain their apple economy. Large farmers of area have the capability to cope with the situation. They have enough money to buy an orchard in other areas where climate is hospitable for cultivation of apple. More than 40 percent of the large farmers of the study area have bought orchards in nearby areas where climate is suitable for apple cultivation. While some of the small and marginal farmers are still trying to maintain their apple orchards and some of them have switched over to vegetables and other fruits.

There is a lot of change in household income contributed by apple during and after the peak period. Apple contributed 100 percent to the house hold income for 30 percent of the farmers and around 90 percent for another 50 percent farmers. For remaining 20 percent of the farmers apple contributed an average of 40 percent to their total income. These figures unveil the fact, that apple was the main source of livelihood for 80 percent of the total households before the phase out period.

TABLE 3

FARMER'S OBSERVATION OF CLIMATE CHANGE IMPACT ON APPLE FARMING (PERCENTAGE OF RESPONSE)

Farmers observation of climate change (increase in temperature, low and erratic rainfall, occurrence of bad weather conditions and decrease in snowfall)	100%
Impact on fruit quality (size, weight, colour etc.) Small size, low weight, poor colour development	100%

Source: Field work

After the phase out period proportion of income from apple in household economy declined drastically and for 100 percent of the families, earning from apple is less than 40 percent of the total house hold income. More than 70 percent of the farmers are in process of rejuvenation of their apple orchards with new varieties of apple but the maintenance cost of these seemingly remunerative varieties is very high. Marginal and small farmers are struggling to rejuvenate and maintain their orchards. Less than 20 percent of the small and marginal farmers have diverted their lands to other vegetables and fruits.

Apple requires a chilling period of 90 days and at least 4-5 inch of snow and moderate amount of rainfall during monsoon season to provide enough water for plantations to grow. Otherwise the quality of the resultant crop is unsatisfactory and the colour of the fruit is affected in particular. All farmers observed some changes in the climatic conditions in the area in form of increase in temperature, low and erratic rainfall, occurrence of extreme weather conditions and decrease in snowfall. This change has also affected the size, weight, juice content and colour of the fruit. Size and weight of fruits have reduced and the colour development is also very poor.

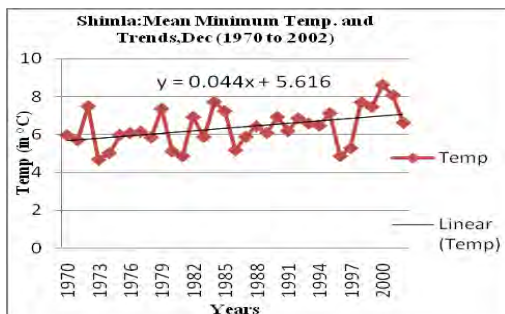


Fig.4. Trends of Mean Minimum Temperature

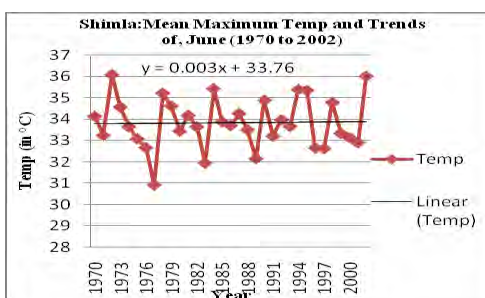


Fig. 5. Trends of Mean Maximum Temperature

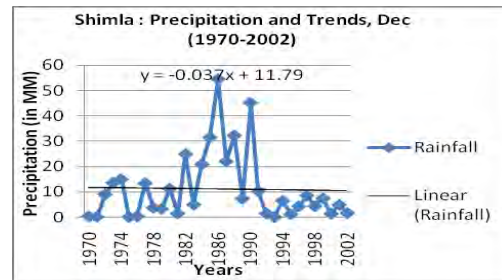


Fig. 6 Precipitation Trends during winters

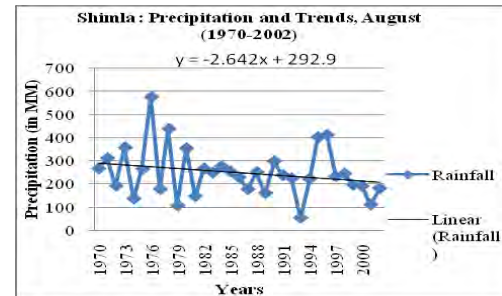


Fig. 7. Precipitation Trends during Summers

According to respondents, duration of winter season has dwindled and average temperatures are also higher during winter months not fulfilling the chilling requirement of the apple. Snowfall has reduced during the winter season. It has reduced from 4-5 feet to 2-3 inch during previous four decades and summers have become prolonged.

It is evident from Fig. 4 that mean minimum temperature of the area during winters has increased by 1°C during the time period 1970-2002. While the trend of mean maximum temperature during summer has shown very minute increase as visible in the fig. 5. This increase in temperature between 1970 to 2002 is a matter of great concern for policy makers, scientists as well as for farmers of the state, because this increase in the temperature is affecting the amount and duration of snowfall in the area. Figs. 6 and 7 depict a decline in precipitation during both winters and summers which is an clear indication of climate change in the study area. All these climatic changes have impacted the size, shape, weight and colour of the apple in Kotgarh. Large apples with a symmetrical shape and full colour fetch a greater value in market. However farmers of Kotgarh these days harvest smaller apples with asymmetrical shape and poor colour having little shine. Due to these reasons farmers are unable to profitably market their produce.

Farmers are facing increasing challenges as climate has now become hospitable for growth of new pests and diseases causing various problems such as root rot, buli ya fid, canker, borer and drying trees. These all diseases affect the apple crops very harshly. To save their crops from these diseases 100 percent of the respondent farmers started the use of fertilizers, pesticides and insecticides after 1980s. These additional inputs increased the cost of production thus lowering the returns. Prior to the introduction of these substances in the farming, farmers of the study area used spray of a liquid solution of diesel, sunlight soap, copper sulphate (*locally known as nila thotha*) and crude oil to protect apple plantations from

various diseases. But gradually this homemade solution became ineffective in controlling crop diseases and pests and farmers were left with no other option but to use chemical fertilizers. In the initial years of use, these chemical substances yielded positive results, nourishing the crop, maintaining the quality and controlling the pests and diseases. But in long run, chemical fertilizers and pesticides degrade the fertility of soil.

As per the opinions of respondent farmers, climate change is a major but not the sole factor affecting apple orchards in the area. Other factors should also be taken note of which are also responsible for the degradation of apple productivity. Many old trees that are fully grown are able to bear the fruits. But the main problem is that the new trees are also not able to survive in changed climatic conditions. Some farmers feel that out-migration of educated youth from the village to urban areas like Shimla, Chandigarh, Delhi etc. for the purpose of job is also responsible for decline in apple production. Education had an early start in Kotgarh as first school was established here in 1873 which was very early as compared not only to other parts of the state but to the nation as a whole. Early start of education led to an increase in literacy level which ultimately led to awareness about birth control leading to a decline in fertility. Nuclear family system came in vogue, resulting in reduced manpower to manage the orchards. Educated generation was unwilling to work in orchards and migrated to urban areas yearning for white collared jobs and gave the responsibility of maintaining and managing their orchards to Nepali migrant labourers. Maintenance of apple orchards requires skilled labour for spraying, pruning and other associated activities, but these migrant laborers were not skilled and were unable to manage and maintain the orchards in an appropriate manner leading to faulty maintenance of orchards. This factor is equally responsible for the degradation of apple produce both in terms of quantity and quality.

Conclusion

Kotgarh was once known for the best quality apples in the country but apple cultivation now has become uneconomical, nonviable, less profitable and even unproductive in a short period. Over the years, fruit growers in the study area have observed significant variations in climate. Impacts of climate change are perceptible as the resultant impacts on apple crop in form of loss of fruit bearing ability, reduction in size of fruit, less juice content, low colour, reduced shelf life and increased attacks of pests and disease. Annual average temperatures have risen and gradual reduction in snowfall has been observed by people. Not only has the actual

amount of snowfall decreased but changes in timing of snowfall have also been noticed. Volume of snowfall in the months of December and January, which have been the months of highest snowfall in the state, has reduced drastically and snowfall now spreads through the months of February-March. Consequently maintaining an apple orchard has become a herculean task. New plantations simply don't survive and older ones are dying fast and farmers have switched over to other fruits and vegetables. But a large number of farmers are still trying to sustain their apple orchards. Study indicates that it is very difficult to sustain the apple economy in the study area as older plantations are dying or are not able to bear fruits and new ones are simply not able to survive in changed climatic conditions of the area. Apple productivity has decreased by 2/3 after the phase out period. Small and marginal farmers are affected most adversely due to climate change as they are not able to maintain their orchards due to high cost of maintenance. While rising annual average temperature is the major factor for the degradation of apple produce and decline in productivity, other factors like lack of skilled labour, use of chemical fertilizers, old trees, and migration of the educated youth are also partially responsible for this decline in productivity.

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