

Role of Extension services in adaptation to climate change in Himachal Pradesh

Discussion Paper 12

MANAGE- Centre for Agricultural Extension Innovations, Reforms, and Agripreneurship (CAEIRA)



National Institute of Agricultural Extension Management (MANAGE)
(An organisation of Ministry of Agriculture and Farmers' Welfare, Govt. of India)
Rajendranagar, Hyderabad – 500 030, Telangana State, India
www.manage.gov.in

Published by

National Institute of Agricultural Extension Management (MANAGE)
(An organisation of Ministry of Agriculture and Farmers' Welfare, Govt. of India)
Rajendranagar, Hyderabad – 500 030, Telangana State, India

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About the Publication

The research report is based on the research conducted by Ms. Anju Kapri as MANAGE intern under the MANAGE internship programme for Post Graduate students.

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Anju Kapri and Saravanan Raj (2020). Role of Extension Services in Adaptation to Climate Change in Himachal Pradesh, Discussion Paper 12, MANAGE- Centre for Agricultural Extension Innovations, Reforms and Agripreneurship, National Institute for Agricultural Extension Management (MANAGE), Hyderabad, India.



PREFACE

I congratulate Ms. Anju Kapri, MANAGE intern and Ph.D. Scholar, Chaudhary Charan Singh Haryana Agricultural University, Hisar, for selecting pertinent topic of the day "Role of extension services in adaptation to climate change in Himachal Pradesh" and collecting good data from field and analysis. In detail, paper analyses the impact, adaptation practices among farmers as well as role of different sectors in adaptation to climate change generally worldwide and particular in India.

Evolution of life on earth has been replete with several changes and transformations. Climate is one such component and defined as the long term pattern of weather in particular area. Any change in climate system leads to a great change in climate. Changing in climate over many years already affect negatively the agricultural production in the range of 1-5%, globally.

Agriculture is the mainstay of Indian economy as about 60% of our population depends directly or indirectly on agriculture. In India, farmers engaged in farming are mostly belonged to small and marginal farmers and climate change affect the agriculture by changing the crop cycle, reducing the yield, decreasing coastal areas under cultivation, affecting physiology of crops which ultimately affects the livelihood of the farmers.

In order to create and strengthen the scientific and analytical capacity for assessment of climate change in the country, several programmes/ schemes have been initiated for addressing climate change includes "National Action Plan on Climate Change" (NAPCC), "National Adaptation Fund on Climate Change" (NAFCC), "Climate Change Action Programme" (CCAP) and "State Action Plan on Climate Change" (SAPCC). The role of extension services in adaptation to climate change are discussed very elaborately. The paper analyses the linkages between sectors and concluded in an easiest and better way.

Dr. Saravanan Raj
Director (Agricultural Extension)

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Abstract

Climate is defined as the long-term pattern of weather in a particular area. Any change in the climate system leads to a great change in climate (NASA, 2011). There are many factors which cause changes in climate. Farmers are the most vulnerable group who are affected most by climate change.

Adaptation is the way to deal with the impact of climate change; that means anticipating the adverse effects of climate change, and taking appropriate action required to minimize the damage that can cause, or take advantages of opportunities that may arise (Sahu and Mishra, 2013). Agricultural extension has a critical role to play in helping farmers in adapting to climate change. At present, extension services are being provided mainly by the public sector through a two-tier system. Besides the existing public extension service system, there are several private players, civil-society organizations including farmer-based organizations and NGOs that play a major role in financing and providing extension services (Birner and Anderson, 2007). For the present study, Himachal Pradesh was selected as farmers of this state are the worst-affected by climate change. Decrease in rainfall and particularly in winter, precipitation coupled with rising winter temperatures are the effects of climate change. Results found that negative impact of climate change is big and erratic in the state. In the state, many technologies given by different sectors are accepted by the farmers for climate change adaptation which includes crop diversification, water management conservation, mulching, mushroom cultivation, organic farming, proper shed for animals, farm pond, storage tanks, etc., which were disseminated by different methods such as seminars, group discussions, Facebook, training, workshop, etc. NICRA project is also active in four districts, working for dissemination of climate resilient practices to the farmers in an effective manner. The study also found that, there are less or no linkages between the public and private sectors for disseminating the practices to the farmers, thus creating barriers to give the proper adaptation to the community. Hence, extension services and their linkages and the agents should be provided with the requisite equipments and logistics so that they can reach farmers easily, with agricultural technologies for adaptation in the face of changing climate. There is also a need to focus on extension systems and programmes that incorporate a good understanding of what practices and skills are needed to best promote activities that help in the climate change effort. There is also a need to increase the capacity of extension agents and farmers where needed.

Executive summary

Climate is a dynamic phenomenon which is assessed by taking into account an average of more than 30 years for the variables like humidity, temperature, wind, precipitation, and other meteorological aspects. There are many factors which cause changes in climate which includes natural and anthropogenic factors. Climate is increasingly affected by humans through burning of fossil fuels, cutting down rainforest and farming livestock which adds huge amount of green house gases in the atmosphere that results increase in green house gases and global warming. Agriculture, except forestry, and other land uses contributes approximately 12 per cent of global GHG emissions. Methane and nitrous oxide are the primary GHGs produced by agricultural activities which comprise about 55 per cent and 45 per cent of emissions from agriculture, respectively (FAO 2017). Top ten CO₂ emitting countries in the world produce around 70 % of global GHG emissions (WRI, 2015). Changing climate over many years already affect negatively the agricultural production in the range of 1-5%, globally. Climate change affects the agriculture by changing the crop cycle, reducing the yield, decreasing coastal areas under cultivation, affecting physiology of crops which ultimately affects the livelihood of the farmers.

The Climate Change Division of Ministry of Environment, Forest and Climate Change (MoEFCC) looks after the issues related to climate change including the international negotiations and domestic policies and actions. Several domestic programmes/schemes have been initiated for addressing climate change, and to create as well as strengthen the scientific and analytical capacity for assessment of climate change in the country. Agricultural extension has evolved over the hundreds of years from a system of top-down dissemination of information from experts to farmers to a more complex system, in which a diversity of knowledge producers and farmers work together to co-produce information. It is increasingly recognized that extension is pluralistic and extension services are often provided by numerous entities working cooperatively (Birner et al., 2006). At present, extension services are



being provided mainly by the public sector through a two-tier system. Besides, the existing public extension service system, there are several private players, civil-society organisations including farmer-based organisations and NGOs that play a major role in financing and providing extension services (Birner and Anderson, 2007). To know the impact of climate change on farmers, what are the different adaptation strategies and role of extension services to cope up with the climate change, present study was conducted in the Himachal Pradesh as state having more vulnerable areas related to climate change. A total of five districts out of twelve were selected to collect the data. Districts having a number of institutions and most vulnerable to climate change were selected to collect the information. Results found that climate change mainly affects the crops in a greater way and different diseases found in the plants and animals.

Many sectors are taking the role for giving services regarding adaptation to climate change. In the state, many technologies are accepted by the farmers given by public sectors for adaptation which includes crop diversification, water management conservation, mulching, mushroom cultivation, organic farming, proper shed for animals, farm pond, storage tanks, etc. These technologies are disseminated by different methods which include seminars, group discussions, Facebook, training, etc. NICRA project is active in four districts, working for dissemination of climate resilient practices to the farmers. The study also found that, there are less or no linkages between public and private sectors for disseminating the practices to the farmers, as it is barrier to give the proper adaptation to the community in a better way. Hence, it is important to focus on improving the linkages between different institutions while making any policy.

Introduction

Evolution of life on earth has been replete with several changes and transformations. Each component of this life the earth has been shaped through countless amount of time to a point that today humanity has become the most dominant species on this planet. Through this process of evolution and change, not every aspect has been beneficial as some changes have in fact created difficulties in the process of life.

Climate is one such component which has a bearing on the very fundamentals of life. This component has been changing in a way that climate change today has become a separate discipline of study in itself.

Climate and its change: definition

Climate is a dynamic phenomenon which is assessed by taking into account an average of more than 30 years for the variables like humidity, temperature, wind, precipitation, and other meteorological aspects.

Climate is defined as the long term pattern of weather in a particular area. Any change in the climate system leads to a great change in climate (NASA, 2011).

According to the United Nations Framework Convention on Climate Change (UNFCCC), climate change refers to “a change of climate which is attributed directly or indirectly to humans’ activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (Anonymous, 2005).

A. Past evidences of climate change

Climate is dynamic in nature and it changes continuously day by day in a very slow manner. Some evidences of this phenomenon includes:

1. Earlier in the current Holocene epoch, parts of what is now the Thar Desert were wet enough to support perennial lakes, due to higher winter precipitation coincide with stronger monsoons (Enzel et al., 1999).



2. Blockage of frigid Central Asian air caused by formation of Himalayas, preventing it from reaching to India which makes climate significantly warmer and more tropical in nature (Wolpert, 1999).
3. Kashmir, once had a warm subtropical climate, shifted to a substantial colder temperature climate (Pant, 2003).
4. In the last century, global sea level rose to about 17 cm which in the last decade became double than that of the last century (Church and white, 2006).

B. Reasons behind climate change

There are many factors which cause changes in climate. Main factor includes natural and anthropogenic factors. Natural factors includes changes in climate caused by natural changes such as volcanoes, continental drifts, earth's tilt, solar output etc whereas, anthropogenic factors which include changes due to human's activities via., industries, energy generation, agriculture, deforestation, etc (Hardy,2003) are responsible for climate change.

Humanity is increasingly affecting climate by burning fossil fuels, cutting down rainforest, and farming livestock which adds enormous amount of greenhouse gases in the atmosphere resulting in the increase in greenhouse gases and global warming.

Present day problem of climate change is largely and primarily man-made in nature such as

- Burning of fossil fuels and biomass is leading to increase in CO₂, while greenhouse gas is reflecting on rise in temperature.
- Change in land use/deforestation will convert forest area to agriculture/housing/industry area. Further, reduction in storage of carbon is affecting the wind, temperature, and rainfall patterns.
- Over-exploitation of natural resources such as excessive use of irrigation and groundwater is reflecting on reduction in water availability and changes in water cycle.
- Release of methane and nitrous oxide gases from poor livestock management, agricultural practices and wetlands will increase the temperatures.

Agriculture, except forestry and other land uses, contributes approximately 12 per cent of global GHG emissions. Methane and nitrous oxide are the primary GHGs produced by agricultural activities which comprise about 55 per cent and 45 per cent of emissions from agriculture, respectively (FAO 2017).

The global warming potentials of CH₄ and N₂O oxide are 25 and 298 times that of carbon dioxide (CO₂), respectively (IPCC 2007). Global warming potential is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time (usually 100 years), relative to the emissions of 1 ton of CO₂.

The greenhouse affects particularly the temperature of the Earth by trapping heat in the atmosphere and retains the temperature of the earth higher than it would be if direct heating by the Sun was the only source of warming (Anonymous, 2010a).

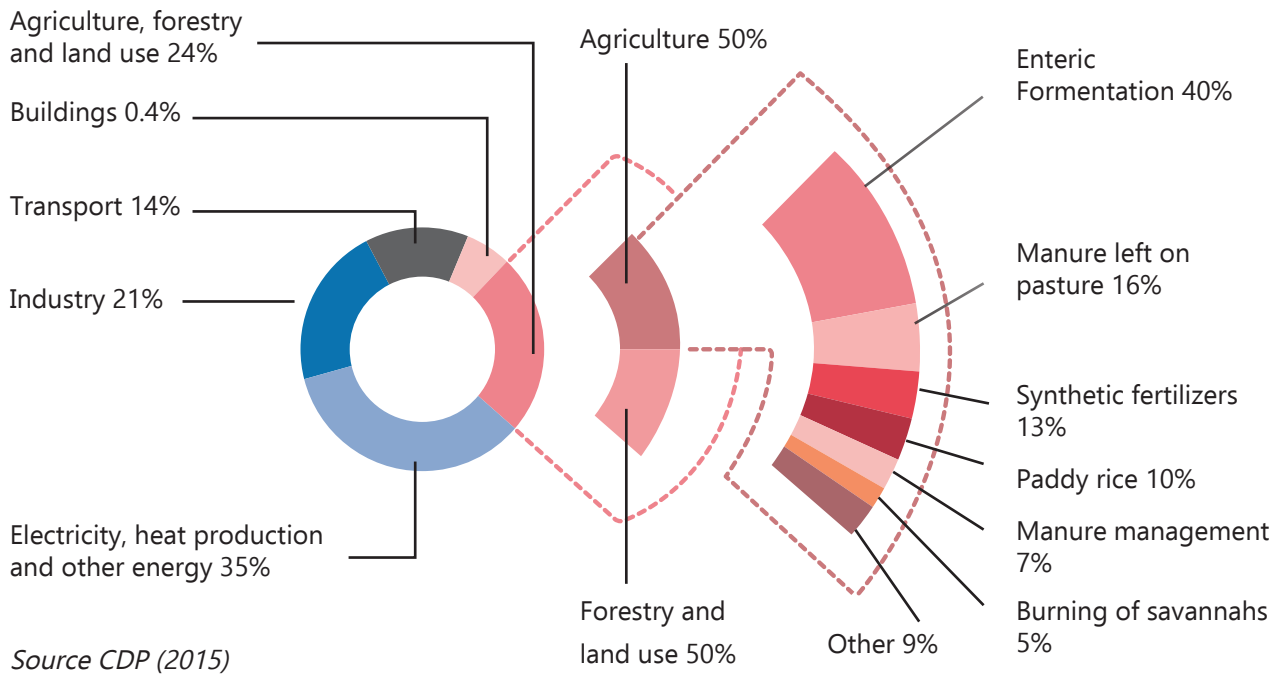


Fig 1: Agriculture and land use currently contribute about 24 per cent of global GHG emissions; about half of that (12 per cent) is from agriculture, and the other half from other land use

The greenhouse effect is mainly caused by the interaction of the sun’s energy with greenhouse gases in the Earth’s atmosphere. The ability of these gases to capture heat caused the greenhouse effect (Anonymous, 2010b).

Carbon dioxide, methane, water vapour, nitrous oxide and ozone are the green houses gases which trap the solar radiations within the atmosphere. These gases absorb and emit radiation within the thermal infrared range and cause greenhouse effect, responsible for increase in temperature of the earth (IPCC, 2018).

Anthropogenic gas emissions from economic sectors

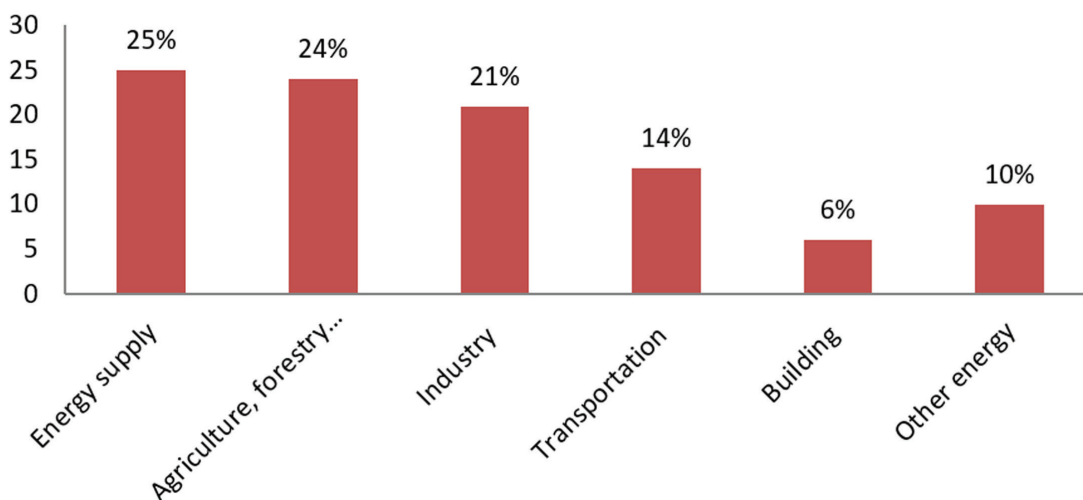


Fig 2: Data (IPCC,2014) on anthropogenic gas emissions from economic sectors include

Greenhouse gases consist of three or more atoms. This molecular structure makes it possible for these gases to trap heat in the atmosphere and then transfer it to the surface which further warms the earth (David, A., 2007).

According to NASA, the Environmental Protection Agency (EPA) and other scientific and governmental bodies, unlimited warming will cause many changes in climate such as rise in sea levels, increasing ocean acidification, life-threatening weather events and other severe natural and societal impacts (NASA, EPA 2011, 2012).

Top ten CO₂ emitting countries in the world produce around 70 % of global GHG emissions (WRI, 2015). Countries like USA, Canada and Australia top the world with highest per capita GDP, highest per capita energy use, and highest per capita CO₂ emission. The UK, Japan, New Zealand, Western Europe and the Middle East dominate the intermediate portion of per capita triangle of GDP, energy use, and CO₂ production whereas India, China and rest of Asia, Africa and Latin America are found at the bottom the pyramid of affluence (IEA, 2016).

India is one of the world's foremost emitters of CO₂. A recent study conducted by Yale and Columbia universities, ranks India 126 out of 132 countries on environmental performances.

India is the world's fourth largest economy and fifth largest greenhouse gas emitter. India accounts for about 5% of global emissions. India's emissions surged 65 per cent between 1990 and 2005 and are projected to increase another 70 per cent by 2020. When compared to other major economies, India's emissions are low. India accounts for only 2 per cent of cumulative energy-related emissions since 1850. On a per capita basis, India's emissions are 70 per cent below the world average and 93 per cent below those of the United States (www.jagranjosh.com/current-affairs).

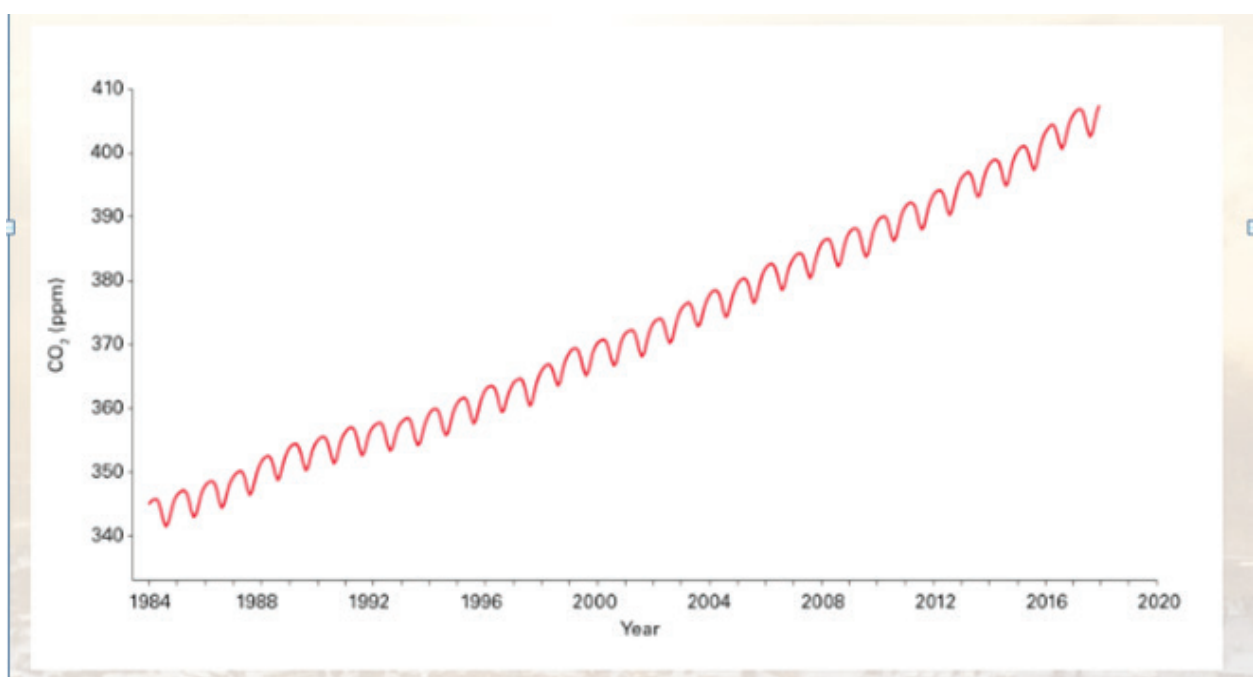


Fig 3: Increase in atmospheric carbon dioxide concentrations in parts per million (ppm)



India's Policies on Climate Change

India has introduced a number of policies that work towards climate change control by reducing or avoiding greenhouse gas emissions. National Action Plan on Climate Change (2008) in India identified eight core "national missions" running through 2017. The goals pertaining to climate change are included in this plan which are-

- Reduce emissions intensity in line with India's Copenhagen pledge; and
- Add 300,000 MW of renewable energy capacity.

The present government has taken steps to scale up clean energy production and has initiated a shift in India's stance in international climate negotiations. One of the government's first acts was to rename the environment ministry as the Ministry of Environment, Forests and Climate Change. Newly reconstituted Prime Minister's Council on Climate Change launched new initiatives on coastal zone management, wind energy, health, and waste-to-energy.

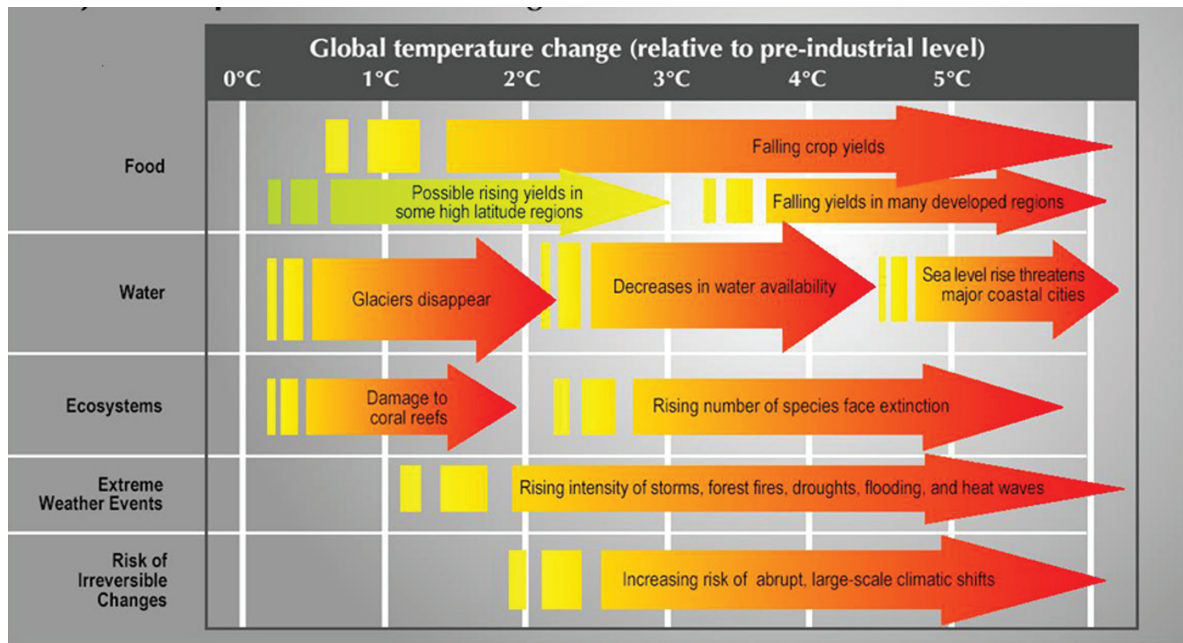
Paris agreement

In Paris, 195 countries signed an agreement to slow the process of global warming in December 2015. The countries pledged to make efforts to hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels to reduce the increase in global temperature rise.

In this agreement, poor countries and island states are requested a lower goal by considering threats of droughts and sea-level rise. The climate experts have also agreed that maintaining a 2 degrees decrease will be a challenge in itself. Another important point in agreement was a decision to limit the amount of greenhouse gases emitted by human activity to a level that can be naturally absorbed by soil, trees and oceans.

Climate experts have said that the agreement meant for attaining "net zero emissions" between 2050 and 2100. In the UN's climate science panel, it was decided that the net zero emissions must be attained by 2070 to avoid dangerous warming. So far, 61 countries, not including India, have already ratified the treaty, and the emissions threshold currently stands at around 47%.

Effects of climate change



C = Celsius; CO₂ = Carbon Dioxide

Source: Adapted from the Stern Review on the Economics of Climate Change.

Fig 4: Projected Impacts of Climate Change

Ocean heat

Study showed that more than 90 per cent of the energy trapped by greenhouse gases into the ocean and ocean heat content provides a direct measure of energy accumulation in the upper layers of the oceans (WMO, 2018).

The ocean absorbs most of the excess heat from greenhouse gas emissions, leading to rising ocean temperatures. Increasing ocean temperatures affect marine species and ecosystems. Rising temperatures cause coral bleaching and the loss of breeding grounds for marine fishes and mammals (IUCN, 2018).

More than 90% of the energy trapped by greenhouse gases, goes into the oceans. Ocean heat content provides a direct measure of the energy that accumulates in the upper layers of the ocean. For each three month period in 2018, the ocean heat content in the upper 700m and upper 2000m were either the highest or second highest on record.



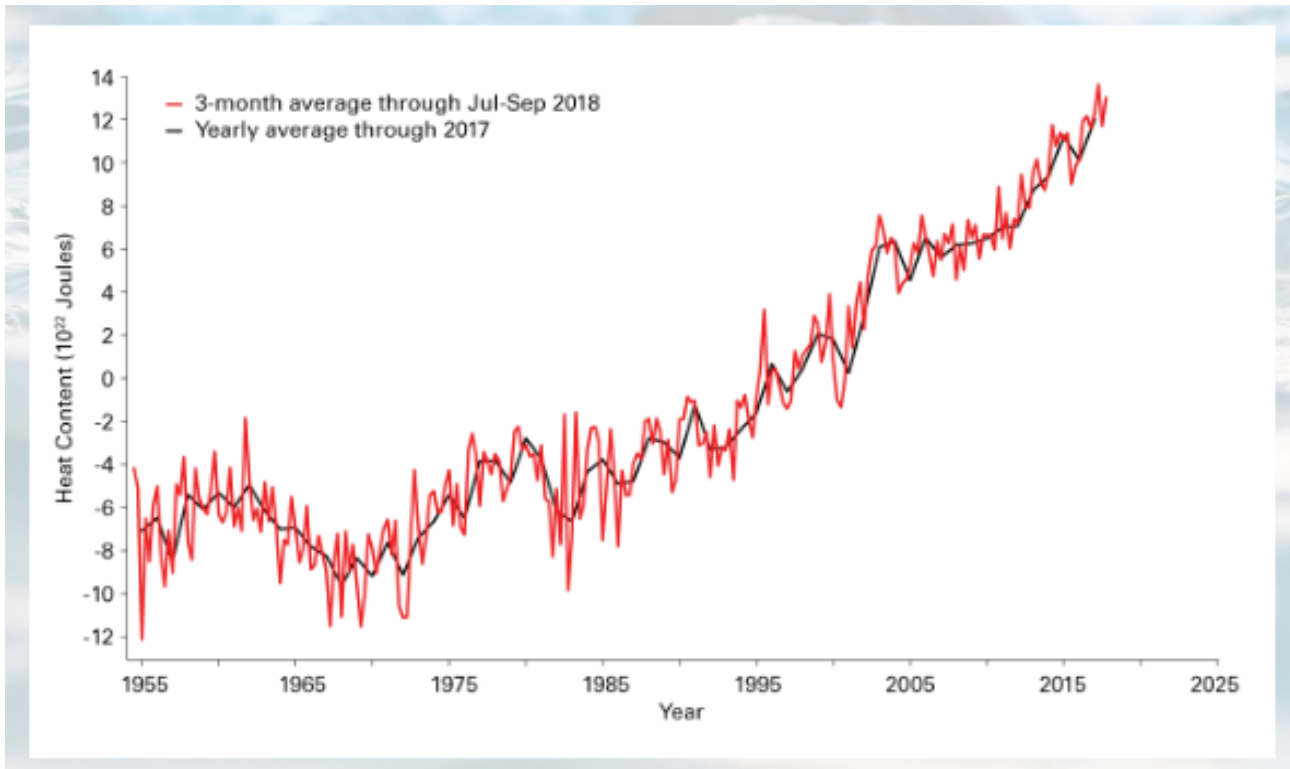


Fig 5: Global Ocean Heat Content (Data Source: NOAA/ NEDIS/ NODC Ocean Climate)

Affecting agriculture

Climate change affects the agriculture by changing the crop cycle, reducing the yield, decreasing coastal areas under cultivation, affecting physiology of crops which ultimately affects the livelihood of the farmers. It was observed that warmer temperature may make many crops grow more quickly but also reduce the yields of the crops.

Sea level

Rise in global mean sea level for 2018 was recorded highest which was around 3.7 mm higher than in 2017. Between the periods of 1993 to 2018 the average rise rate recorded to be 3.15 ± 0.3 per year while the estimated acceleration was 0.1 mm per second year. The main cause of rise in global mean sea level may be due to the higher loss of ice mass from the ice sheets (WCRP, 2018).

Mean Global mean sea level for the period from January to July 2018 has been 2 to 3mm higher than for the equivalent period in 2017.



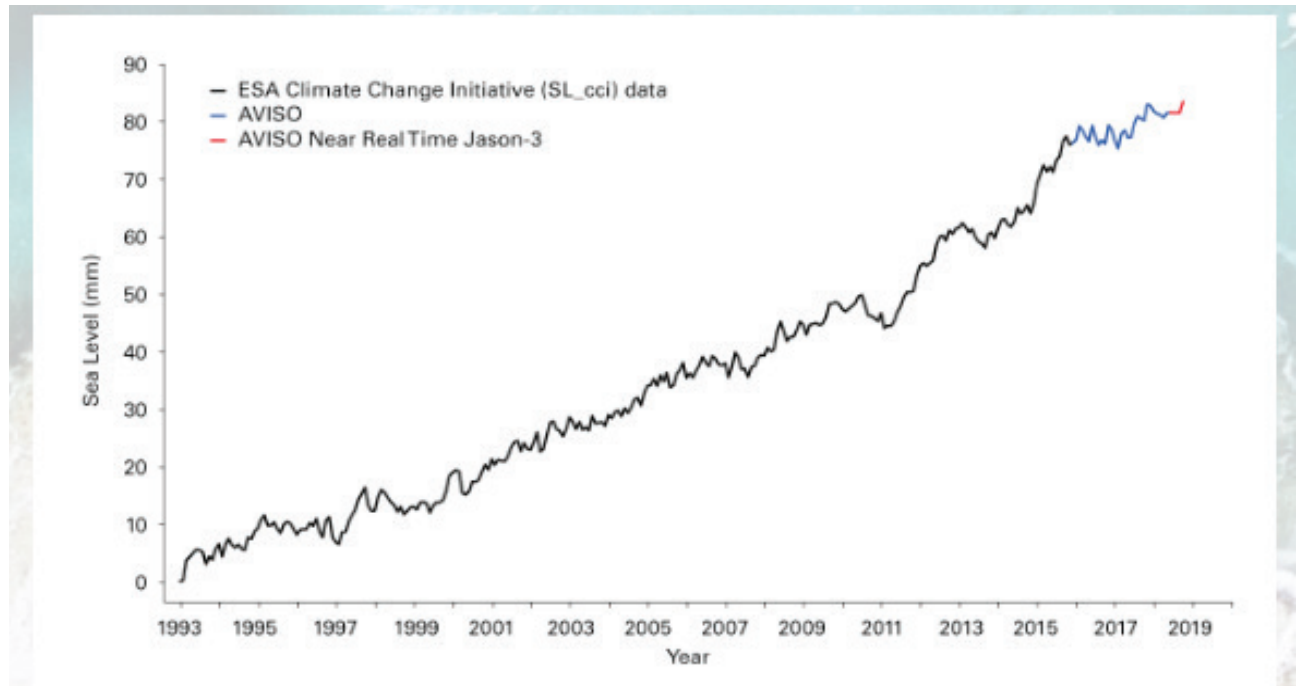


Fig 6: Global Mean Sea Level

Ocean acidification

Previously, oceans absorbed around 30 per cent of anthropogenic CO₂ emissions which reacts with sea water and changes the pH of the ocean, this process, known as acidification of ocean, has resulting affects on the ability of marine organisms like molluscs and reef-building corals, to build and maintain shells and skeletal material. According to UNESCO-IOC report ocean acidification is ongoing and the global pH level continues to decrease.

Increase in pest and disease

Climate change affects the land and oceans that causes changes in the distribution of the species around the world with an overall shift away from the equator and towards the poles which alarmingly increases the outbreaks and epidemics of diseases (Barford, 2013).

Sea ice

The study determined that the level of melt events across the Greenland ice sheet have not occurred in at least the past 500 years. The Arctic sea ice extent was well below average throughout 2018 and was at record-low levels for the first two months of the year.

Glacier retreat

World Glacier Monitoring Service mainly monitors the glacier mass balance by using a set of global reference glaciers with more than 30 years of observations from 1950-2018. Result observed that the hydrological year was the consecutive year of negative mass balance.

Global context of climate change

Due to high accumulation of GHG in the atmosphere, the world had warmed by $0.13 \pm 0.03^\circ\text{C}$ per decade during the period between 1956 and 2006. It increased per decade before 1956 to $0.07 \pm 0.02^\circ\text{C}$. Before 1850 (El Nino), the temperature was relatively stable which later became warmest in 1998 followed by 2005, 2003 and 2010. The coolest year was 2011 (La Nina, Langmiur and Broecker, 2012). The maximum increase in temperature occurred close to the poles mainly in the Arctic, where snow and ice cover have decreased substantially (karl et al., 2009, Tomkin and Deconscini, 2015, Walsh et al., 2014).

Globally, millions of people living in low lying coastal areas of the world are affected by flood (Henkal et al., 2014). Maximum number of cyclones and flood was recorded in the northern Indian Ocean in year 1975, whereas, Southern Indian Ocean records more than average occurrence of extreme event (Jansen et al., 2007).

The annual occurrence of cyclones and storms in the eastern Pacific has been low i.e., less than 10 events per year as compared to western pacific which recorded high occurrence of extreme events (avg. about 24 events per year). The storms and cyclones in the world oceans since 1945 have been highest in terms of percentage in the west Pacific, followed by the east pacific, Southern Indian Ocean, Atlantic Ocean, and Northern Indian Ocean (Westerink, 2008; Muis et al., 2016 and Rappa port, 2014).

In 2004, the Indian Ocean Tsunami that hit Indonesia, Sri Lanka, India, Thailand, and the Maldives took away about 230,000 lives caused damage to property, infrastructure and economy.

Table 1: Number of climate disasters in South Asia between 2005 and 2014

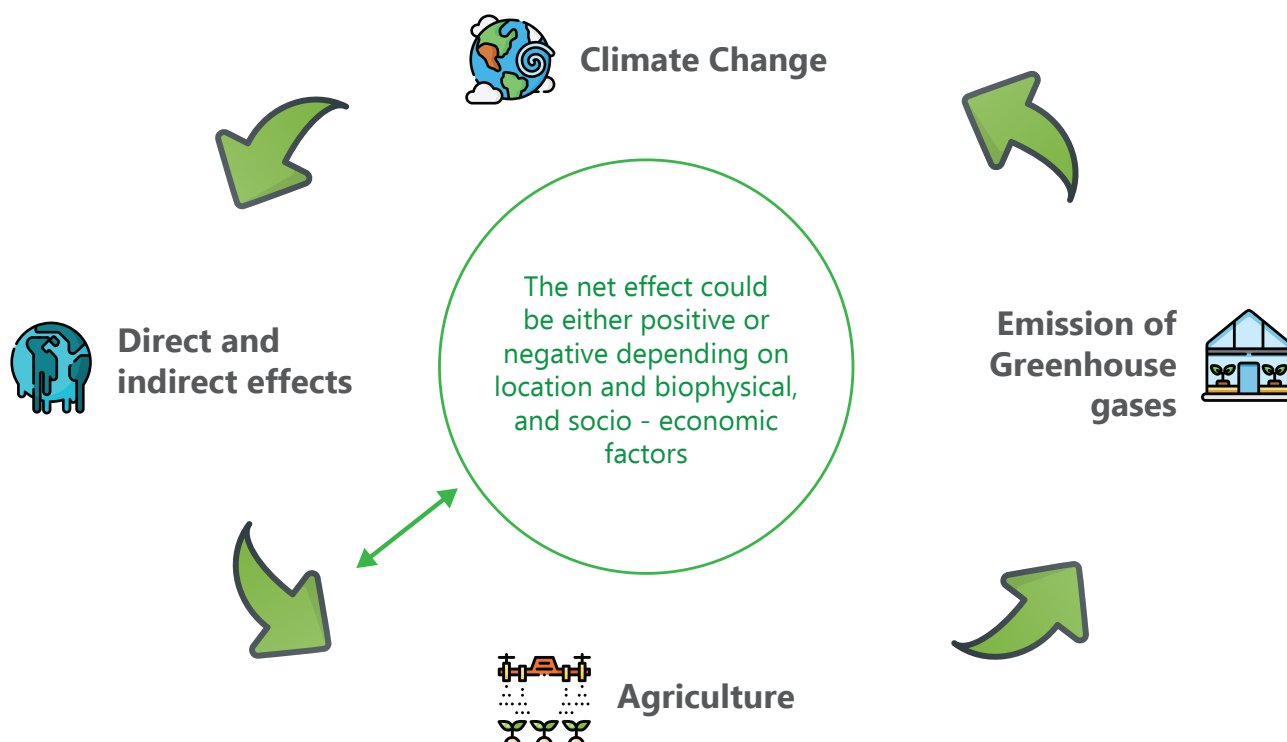
| Country | No. of flood events | No. of drought events |
|-------------|---------------------|-----------------------|
| Afghanistan | 41 | 3 |
| Bangladesh | 16 | 1 |
| India | 93 | 1 |
| Maldives | 1 | - |
| Nepal | 14 | 2 |
| Pakistan | 35 | - |
| Sri Lanka | 20 | 1 |

Source- EM DAT- the emergency events database. www.emdat.be, Brussels, Belgium.

Data from IPCC, 2013 found that over the last few decades, heavy rainfall has increased both in frequency and intensity by 20 per cent resulting in Hurricanes in the Atlantic and eastern pacific became severe. Due to increase in temperature, heat waves are also occurring more frequently. Australia and Southeast Asia have experienced heavy rainfall and increased droughts, coinciding with rising temperature over the past 50 years.

Climate change and agriculture

Changing in climate over many years already affect negatively the agricultural production in the range of 1-5%, globally. Most of the time, we only focus on the effect of agriculture and ignore the effect of agriculture on climate. A study conducted by Sharma et al. (2011) reported the contribution of Indian agriculture to total emission of GHGs at about 19 per cent (Lenka, Lenka and Rao, 2013). There are mainly two anthropogenic sources of GHGs emission from agriculture which include energy use in agriculture and management of agricultural land.



Source - Tripathi and Mishra, 2017

Climate change is affecting agriculture in a big way and its impacts are many and serious. Some effects are positive and some are negative such as-

Crop yield

Warmer temperatures may make crops grow faster but reduce the yield. In crops such as grains, faster growth reduces the amount of time that seeds have to grow and mature which reduces yield of crops.

On the other hand, an increase in CO₂ increases the yield. According to Council, 2012 yield for some crops like wheat and soy bean could increase by more than 30 per cent doubling CO₂ concentrations, while crops like corn exhibits a much smaller response, i.e., increase by less than 10 per cent.

The Indian Council of Agricultural Research (ICAR) has predicted significant impact of climate change

on crop yields in major food crops such as rice, wheat, sorghum (2020, 2050 and 2080 scenarios), maize (2030 and 2080) under the National Project on Climate Change (NPCC). Climate change may likely benefit certain crops such as chickpea, soybean and potato in India.

Rice

Irrigated rice yields are projected to reduce by 4 per cent in 2020, 7 per cent in 2050, and by 10 per cent in 2080 scenarios. On the other hand, rain-fed rice yields in India are projected to reduce by 6 per cent in the 2020 scenario, but in 2050 and 2080 scenarios, they are projected to decrease marginally (<2.5 per cent). Adopting improved varieties and input management can enhance the yields by 6-17 per cent under irrigated conditions and by about 20-35 per cent in rain-fed conditions. Another study conducted by All India Coordinated Research Project on Agrometeorology (AICRPAM) of ICAR-CRIDA revealed that annual mean minimum temperature showed warming @ 0.24° (unit missing) per decade (10 years) on all-India basis. The magnitude of rise in seasonal mean temperatures is more during rabi (0.28 °C 10 yr⁻¹) compared to kharif (0.19 °C per decade). Kharif paddy yields in 268 districts across the country (57.2 per cent of paddy growing area) were affected by a rise in minimum temperature. Decline in Kharif paddy yield ranged between 411 and 859 kg ha⁻¹ per 1 °C rise in minimum temperature across different regions of India.

Wheat

Climate change is projected to reduce the timely sown irrigated wheat production by about 6 per cent in 2020 scenario from the existing levels. However, late and very late sown wheat yields are projected to decrease by about 18 per cent in 2020, 23 per cent in 2050, and 25 per cent in 2080 scenarios, if no adaptation is followed. However, adaptation by sowing improved varieties coupled with good agronomic management can improve the yields by about 10 per cent in 2020 (2010-2040) scenario.

Maize

Climate change is projected to reduce the irrigated kharif maize yields by up to 18 per cent in 2020 scenario, if no adaptation is followed. However, adaption of technologies such as improved varieties and agronomic management can improve the yields by about 21 per cent in 2020 scenario. Climate change in 2050 and 2080 scenarios is projected to reduce the irrigated kharif maize yields by 18 to 23 per cent and with the adaptation practices, yields are projected to improve by about 10% in 2050 and by 4 per cent in 2080 scenario.

Sorghum

Rain-fed sorghum yields, on all-India scale, are projected to marginally (2.5 per cent) decline in 2020 scenario, while it is projected to decline by about 8 per cent in 2050 scenario. Adaptation strategies such as improved and tolerant varieties with application of higher dose of nitrogen fertilizer can

enhance the irrigated maize net production by about 21 per cent in 2020, 10 per cent in 2050 and 4 per cent in 2080 scenarios.

Soybean

Likely increase in kharif soybean yield in the range of 8-13 per cent under different future climate scenarios (2030 and 2080) is predicted.

Groundnut

Kharif groundnut yields are projected to increase by 4-7 per cent % in 2020 and 2050 scenarios, whereas in 2080 scenario, the yield is likely to decline by 5 per cent.

Chickpea

Future climates are likely to benefit chickpea by an average increase in productivity ranging from 23 to 54 per cent. However, a large spatial variability in the magnitude of change in productivity is projected.

Potato

Climate change may likely benefit potato in Punjab, Haryana, and Western and Central UP by 3.46 to 7.11 per cent by 2030. In West Bengal and Southern plateau region, potato production may likely to decline by 4 - 16 per cent by 2030.

Horticulture

The established commercial varieties of fruits, vegetables and flowers perform poorly in an unpredictable manner due to climate change. The melting of ice-caps in the Himalayan region has reduced the chilling effect required for the flowering of many of the horticultural crops like apple, orchid, etc. In Himachal Pradesh, consequent to warming and reduction in chilling temperatures, apple cultivation has shifted to higher elevations. Commercial production of horticultural plants, particularly grown under open field conditions, will be severely affected. Due to high temperature, physiological disorder of horticultural crops will be more pronounced, e.g.- Spongy tissue (gourds), fruit cracking (pomegranate), flower and fruit abscission (mango, citrus, tamarind), etc.

Air pollution also significantly decreases the yield of several horticultural crops and increases the intensity of certain physiological disorder like black tip of mango.

Food

Increase in temperature, and frequency of droughts and floods are likely to affect crop production negatively, which could increase the number of people at risk from hunger and increased levels of

displacement and migration. These changes can further alter the health status of millions of people, including increased deaths, disease and injury due to heat waves, floods, storms, fires, and droughts.

Increased malnutrition, diarrhoea and malaria in some areas increase the vulnerability to extreme public health. The development goals will be threatened by long-term damage to health systems from disasters.

Livestock

Yield of milk can reduce by 10-30 per cent due to heat wave in first lactation, whereas, 5-20 per cent in second and third lactation in cattle and buffaloes which affect the growth, puberty, and maturity of crossbreeds of animals (Rao, 2012).

Changes in climate affect animals both directly and indirectly such as-

- Heat waves, which are projected to increase under climate change, could directly threaten livestock. Over time, heat stress can increase vulnerability to disease, reduce fertility, and reduce milk production.
- Climate change may increase the prevalence of parasites and diseases that affect livestock. The earlier onset of spring and warmer winters could allow some parasites and pathogens to survive easily. In areas experiencing increased rainfall, moisture-reliant pathogens could thrive.
- Drought may threaten pasture and feed supplies. Drought reduces the amount of quality forage available to grazing livestock. Some areas could experience longer, more intense droughts, resulting from higher summer temperatures and reduced precipitation. For animals that rely on grain, changes in crop production due to drought could also become a problem.
- Potential changes in veterinary practices, including an increase in the use of parasiticides and other animal health treatments, are likely to be adopted to maintain livestock health in response to climate-induced changes in pests, parasites, and microbes. This could increase the risk of pesticides entering the food chain or lead to evolution of pesticide resistance, with subsequent implications for the safety, distribution, and consumption of livestock and aquaculture products.

Weed

Under warmer temperature many weeds, fungi and pests flourish which cause problems for farmer's crop.

Seed quality

Seed quality includes several parameters like physical and genetic purity of seeds, seed germination, viability, seed health and appearance like size, shape, weight and colour which depends on climatic variables. In adverse condition of climate, seed quality reduces results, thereby, lowering the value in the market which ultimately affects the economy of farmers (Maity and Pramanik, 2013).

Soil

Changes in temperature and precipitation leads to soil structure degradation and decrease the porosity, as well as increased runoff and erosion on sloping sites resulting rapid segmentation (Brinkman and Sombroek, 1996).

Water

Agriculture sector is the largest consumer of surface water in India and the demand of water is increasing day by day by increase in area under irrigation but climate change is affecting hydrological cycle such as changing precipitation pattern, intensity and widespread melting of snow and ice, increasing evaporation etc, causes decrease in ground level water table which changes soil moisture region (Pathak et. al, 2014).

Of the total precipitation of around 4000 km³ in the country, the availability from surface water and replenishable groundwater is estimated at 1869 km³. Owing to variations of topography, and an uneven distribution of rain over space and time, only about 1123 km³, including 690 km³ from surface water and 433 km³ from groundwater resources can be put to beneficial use.

India has 20 river basins having a total catchment area of 2.53 Mkm². The largest is the Ganga-Brahmaputra-Meghna system, which has an area of about 1.1 Mkm² (more than 43 per cent of the total catchment area of all the major rivers in the country). The other major basins with catchment areas of more than 0.1 Mkm² are those of the Indus, Mahanadi, Godavari and Krishna. There are a further 46 medium river basins with catchment areas of between 2000 and 20 000 km², whose total area is about 0.25 Mkm².

Creation of a large irrigation potential has been the cornerstone of India's agricultural growth and past food security. This will be affected considerably by climate change as well as by future changes in the effectiveness of irrigation methods. Climate change scenarios have an impact on the hydrological cycle, which, in turn, is likely to result in:

- (i) greater rainfall intensity
- (ii) decrease in number of rainy days
- (iii) overall increase in precipitation
- (iv) an initial increase in glacial melt and run-off, followed by a decrease
- (v) increase in run-off and reduced groundwater recharge
- (vi) an increase in flood as well as drought conditions.

These changes will affect the supply of water from inflow from rivers, reservoirs, tanks, ponds and total replenishable groundwater resource.

It has been observed through remote sensing that several monsoon-influenced glaciers are retreating. The increased melting and recession of glaciers associated with climate change could further alter

the run-off. Any increase in melting of glacier in the Himalayas is likely to affect the availability of irrigation water, especially in the Indo-Gangetic plain. More than one-sixth of the world's population is currently dependent on melted water from mountain ranges. Melting of glaciers is facilitating flooding of agricultural cropped area and leading to loss of food crops and productivity, which in turn, reflects on the food security of the nation.

Vagaries of monsoons are mainly due to El-nino effect. Further, the amount of rainfall received also varies with the geographical regions (e.g. Rain shadow regions). Erratic rainfall and abrupt ending of monsoons are promoting drought situations in different agro-climatic conditions, which is hampering food security and livelihood opportunities.

Crop duration

The most critical stage of crop development is time of anthesis. Increase in temperature reduces the seed set resulting decrease in yield of crop (Craufurd and Wheeler, 2009).

Organizations actively work on the issue of climate change

1. Climate Action Network
2. Climate vulnerable forum
3. Citizens Climate lobby
4. Carbon war room
5. Worldwide view on global warming
6. Ecosystem market place
7. Sierra student Coalition
8. Project EVIE
9. National Energy foundation
10. APEC climate centre
11. Save the climate
12. Global cool
13. Air resources laboratory
14. China carbon forum
15. UK youth climate coalition
16. Climate research unit
17. German climate consortium
18. Youth climate movement
19. Sandbag
20. Climate hawks vote
21. Cool earth
22. Canadian youth climate coalition

The Climate Change Division of Ministry of Environment, Forest and Climate Change (MoEFCC) looks

after the issues related to climate change including the international negotiations and domestic policies and actions. India is a Party to the United Nations Framework Convention on Climate Change (UNFCCC), Paris Agreement and Kyoto Protocol. The Division is also responsible for submission of National Communications (NATCOMs) and the Biennial Update Reports (BURs) to UNFCCC.

Several domestic programmes/ schemes have been initiated in the recent years for addressing climate change. Some key initiatives include the National Action Plan on Climate Change (NAPCC), National Adaptation Fund on Climate Change (NAFCC), Climate Change Action Programme (CCAP) and State Action Plan on Climate Change (SAPCC). In order to create and strengthen the scientific and analytical capacity for assessment of climate change in the country, different studies have also been initiated under CCAP (PIB, GOI, 2018).

Govt missions under National Action Plan on Climate Change (NAPCC)

- a) National Solar Mission (2010)
- b) National Mission on Enhanced Energy Efficiency (2009)
- c) National Mission on Sustainable Habitat
- d) National Water Mission (2010)
- e) National Mission for Sustaining the Himalayan Ecosystem (2014)
- f) National Mission for a Green India (2014)
- g) National Mission for Sustainable Agriculture (2010)
- h) National Mission on Strategic Knowledge for Climate Change (2010)

Indian agriculture

Agriculture is the main occupation for people living in India thus it became the second largest country in the world in the field of agriculture. India is using about 180 million hectare land, 60.5 per cent of total land area and in total, the sector contributes about 14 per cent of total GDP and employs more than 50 per cent of the total workforce. In spite of the steady decline in agriculture's contribution to the total GDP, farming is the biggest industry in India and plays a key role in the socio-economic development of the country.

Table 2: Production of Major Agricultural Crops (3rd Adv. Est.)

| Crops | Production (Million Tonnes) | | | | | | |
|--------------------------|-----------------------------|--------------|--------------|--------------|--------------|-----------------|------------------|
| | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 (Final) | 2018-19 (3rd AE) |
| Total Food Grains | 257.1 | 265.0 | 252.0 | 251.6 | 275.1 | 285.0 | 283.4 |
| Rice | 105.2 | 106.7 | 105.5 | 104.4 | 109.7 | 112.8 | 115.6 |
| Wheat | 93.5 | 95.9 | 86.5 | 92.3 | 98.5 | 99.9 | 101.2 |
| Total Coarse Cereals | 40.0 | 43.3 | 42.9 | 38.5 | 43.8 | 47.0 | 43.3 |
| Total Pulses | 18.3 | 19.3 | 17.2 | 16.4 | 23.1 | 25.4 | 23.2 |
| Total Oil Seeds | 30.9 | 32.8 | 27.5 | 25.3 | 31.3 | 31.5 | 31.4 |

| | | | | | | | |
|-----------|-------|-------|-------|-------|-------|-------|-------|
| Sugarcane | 341.2 | 352.1 | 362.3 | 348.4 | 306.1 | 379.9 | 400.4 |
| Cotton# | 34.2 | 35.9 | 34.8 | 30.0 | 32.6 | 32.8 | 27.6 |

Source: DES, DAC & FW, M/o Agriculture & Farmers Welfare.

Note: 3rd AE: 3rd Advance Estimates; # Million bales of 170 kgs. each.

India is the world's largest producer of many of the fruits and vegetables, milk, spices, cotton, jute, millet etc as well as the second largest producer of wheat, rice, tobacco, silk and sugarcane (FAO, 2018).

All India production of food-grains: As per the 3rd Advance Estimates for 2018-19, the total production of foodgrains during 2018-19 is estimated at 283.4 million tonnes compared to 285 million tonnes in 2017-18 (economic report, May-2019).

But now, due to change in climate and dependency on rainfall and irrigation, production of food grains decline by 3 per cent (Mohan, 2015). Farmers are facing number of problems due to erratic monsoon, changes in agricultural zones, spread of tropical diseases, sea level rise, changes in availability of fresh water, floods, droughts, heat waves, storms, hurricanes etc.

The cumulative rainfall received for India as a whole during the period 1st June 2019 to 2nd July 2019 has been 30 percent below normal. The actual rainfall received during this period has been 128.1 mm, as compared to the normal rainfall of 183.2 mm. Out of the total 36 meteorological subdivisions, no subdivision received large excess rainfall, 1 subdivision received excess rainfall, 8 subdivisions received normal rainfall, in 25 subdivisions rainfall was deficient, 17 subdivisions received large deficient rainfall and 2 subdivisions remained without rainfall during the period (economic report, July-2019).

Ways to cope up with climate change

Farmers are the most vulnerable group who gets affected more by changes in climate. Between 2006 and 2016, 26 per cent of the total damage and caused by climate-related disasters in developing countries in the agriculture sector. IPCC warns that declining crop yields may already be a fact, and that decreases of 10-15 per cent may be widespread by 2050. They are expected to face all the increasing challenges and perform better than earlier. By three ways farmers can cope up with climate change and can decrease the effect of climate change which includes monitoring, mitigation and adaptation to climate change.

Adaptation is the way to deal with the impacts of climate change that means anticipating the adverse effects of climate change and taking appropriate action needed to minimize the damage that can cause, or taking advantages of opportunities that may arise (Sahu and Mishra, 2013).

Some practices that help in adapting to climate change in Indian agriculture includes soil organic carbon build up, in-situ moisture conservation, residue incorporation instead of burning, water

harvesting and recycling for supplemental irrigation, growing drought and flood tolerant varieties, water saving technologies, location specific agronomic and nutrient management, improved livestock feed and feeding methods.

Institutional interventions promote collective action and build resilience among communities. Capacity building by extensive participatory demonstrations of location specific agricultural practices helps farmers gain access to knowledge and provides confidence to cope with adverse weather conditions (Mohan Kumar, 2018).

Agricultural technology shared across regions-

Global

According to frequency in descending order

1. Silvopasture
2. Conservation agriculture
3. Green manure/cover crops
4. Water management
5. Improved Pasture, Biogas, Intercropping, Tree management, Mulching, Reduced/No tillage

LAC

According to frequency in descending order

1. Intercropping
2. Green manure/cover crops
3. Silvopasture
4. Conservation agriculture
5. Mulching
6. Improved Pasture
7. Grazing management
8. Fertilizer management
9. Water management
10. Crop tolerance to stress

Africa

According to frequency in descending order

1. Silvopasture
2. Conservation agriculture
3. Water management
4. Biogas
5. Integrated pest management
6. Aquaciviculture, Improved pasture, Green manures/ cover crops
7. Intercropping
8. Improved rice management

Asia

According to frequency in descending order

1. Biogas
2. Diet management, Conservation agriculture
3. Genetic improvement, Integrated nutrient management
4. Organic inputs
5. Intercropping
6. Aquasilviculture, Water management

Role of Agricultural Extension services in adaptation to climate change

Agricultural extension has evolved over the hundreds of years from a system of top-down dissemination of information from experts to farmers to a more complex system, in which a diversity of knowledge producers and farmers work together to co-produce information. Agriculture has always been a challenging profession, with farmers at the whim of government regulations, trade agreements, uncooperative weather, and changing consumer preferences, climate change arguably poses the greatest challenge yet.

Agricultural extension has a critical role to play in helping farmers in adaptation to climate change. It is increasingly recognized that extension is pluralistic and extension services are often provided by numerous entities working cooperatively (Birner et al., 2006). This has led to some calls to rename agricultural extension as “agricultural advisory services” to be more inclusive than extension has been in the past (Birner et al., 2006).

At present, extension services are being provided mainly by the public sector through a two tier system. At the central level, Indian Council of Agriculture Research (ICAR) is the nodal institute for agriculture research and extension; while at the state level, the State Agricultural Universities (SAU) facilitate agriculture extension via the KrishiVigyan Kendra (KVKs) and Agriculture Technology Management Agency (ATMA) at the district level.

Besides the existing public extension service system, there are several private players, civil-society organizations including farmer-based organizations and NGOs that play a major role in financing and providing extension services (Birner and Anderson, 2007).





Objectives of the study:

The present study focussed on how farmers are affected by climate risks, what the climate resilient practices are, and how different are the adaptation strategies, and role of extension services to cope up with the climate change. Thus, in order to gather insight into these issues, the present project entitled, "Role of extension services in adaptation to climate change in Himachal Pradesh" was proposed to be conducted entailing the following objectives:

1. To study the impact of climate change on farmers of Himachal Pradesh
2. To elicit climate adaptation practices followed by farmers for climate resilience
3. To know the role of existing extension services in climate change adaptation in Himachal Pradesh

Operational definition

Impact of climate change- Impacts of climate change is operationally defined as the degree to which, severity of climatic parameters and their ill effects as perceived by farmers on crop production, animal husbandry, food security, energy and water, occurrence of disease and pest, social dislocation etc.

Adaptations to climate change

Adaptations to climate change are the adjustments or alterations which are introduced by farmers in order to manage the losses or to take advantage of changes in climate. Adaptation, for the present study, will include actions taken to reduce the negative consequences of changes in the climate (e.g. switching to climate sensitive crops, Soil and water conservation, inter cropping, mulching, developing an effective early warning system, extending insurance, avoiding deforestation, energy conservation etc.).

Locale of the study

Climate change is a reality as far as farmers in Himachal Pradesh are concerned and they are the worst-affected. Decrease in rainfall particularly in winter, precipitation, coupled with rising winter temperatures have adversely affected the conditions.

Himachal Pradesh was the locale of the present study. Himachal Pradesh is situated in the western Himalayas. It extends from the latitudes 30°22'40" North to 33°12'40" North and longitudes 75°45' 55" East to 79°04' 20" East. Located in the northern part of India, the state stands bordered by Punjab in the west, Uttar Pradesh in the southeast, China in the east, Haryana in the southeast, and Jammu and Kashmir in the north (www.bharatonline.com). The entire state of Himachal has a hilly and rugged terrain, with the altitude ranging from 350 meters to 7000 meters above sea level.



Fig 7: Selected districts of Himachal Pradesh

Although agriculture dominates the economy of the State because of the mountainous terrain, only a little over 10 percent of the total land area is cultivated. Population pressure on cultivated land is high and the holdings of most of the cultivators are small and scattered i.e. 88.00% of the farmers are small and marginal. Most of the holdings are self-cultivated. About 20% of the cultivated area is under irrigation and remaining 80% of the area is rain-fed. Cultivation is carried out right from 300 to 3000 meters above sea level. Agro-climatically, the region is more suitable for growing off-season vegetables and temperate fruits. Animal Husbandry and Fisheries also generate wealth and employment in the Agriculture Sector. (Climate Action plan 2018-19).

There are many constraints in Himachal Pradesh for doing agriculture which includes problem of erosion due to serious topographical and climatic factors and abiotic pressure on the land. More

rain-fed area, small and scattered land holdings, occurrence of natural calamities like drought, cloud bursts, hailstorm, heavy rains, storms, unusual rise in temperature are quite frequent causing losses to crops, other problems include squeezing of agricultural lands because of diversion to non-agricultural purposes, inadequate infrastructure like rural roads, irrigation, marketing grading and packing facilities of agricultural produce etc.

Current Actions for Adaptation & Mitigation in Himachal Pradesh

Agriculture

The Department of Agriculture is working with responsibility for the economic up-liftment of the farming community of the State through planned agriculture development with a strategy for future sustainable agriculture. Production and improvement in productivity and quality through various adaptive measures such as setting up of 21 Seed Multiplication Farms where Foundation Seeds of Kharif and Rabi crops are being produced have also been initiated.

Annually, about 3,500 to 4,000 qtls seed of Cereals, Pulses and Vegetables are produced. Besides this, the department has established 11 Soil Testing Labs and 4 Mobile Soil Testing Labs to provide free soil testing facilities to the farmers.

There are 13 Potato Development Stations in the State where Foundation Seed Potato is being produced. More area is being diversified for undertaking production of cash crops and market potato as table variety, and produce only that much seed potato which can easily be marketed outside the State. The diversification is towards market oriented demand of high value cash crops/vegetables. Three Vegetable Seed Farms have been set up in the State where Quality Seed is being produced.

Besides this, two Training Centers, one at, Mashobra in District Shimla and another at Sundernagar, District Mandi have been established. Further, farmers' training camps are organized at Village, Block, and District levels. Weather Based Crop Insurance Scheme (WBCIS) has been introduced for different crops. Two risk financing programmes which support adaptation to climate impacts have been started. The Crop Insurance Scheme supports the insurance of farmers against climate risks, and the Credit Support Mechanism facilitates the extension of credit to farmers, especially for crop failure due to climate variability.

The Department of Agriculture also is participating in RIDF for creation of irrigation potential through Minor Irrigation/ Water Harvesting Structures. The programme for the production of cash crops through adoption of precision farming practices through poly house cultivation and Project on Diversification of Agriculture through Micro-Irrigation and other related infrastructure is also being implemented in the State.

"Seed Village Programme" by which sufficient seed multiplication can be achieved in order to meet local seed requirements is being implemented besides facilitating supply of seeds at reasonable cost

and ensuring quick multiplication of new varieties in a shorter time. Under this programme, areas of better seed production will be identified and a compact area approach will be followed. The adoption of organic agriculture on one hand, is expected to provide sustainability, while on the other, it will help in increasing the income of the farmers.

The Government of India has launched a National Project on Agriculture in order to promote organic farming in the State. Under this project, financial assistance was being provided for setting up of Model Farms, training of farmers, setting up of vermi composting units, hatcheries etc. For promoting organic farming, a project was taken up in Shimla District in collaboration with Morarka Foundation and District Rural Development Agency, Shimla. The current programmes aim to minimize the adverse effects of drought on production of crops and livestock, and on the productivity of land, water and human resources, so as to ultimately lead to drought proofing of the affected areas.

It also aims to promote overall economic development and improve the socio-economic conditions of the resource poor and disadvantaged sections inhabiting the programme areas or affected areas. The Horticulture Technology Mission programme funded by Government of India is taking care of adaptation actions to combat climate change impacts as well as capacity building of extension workers, farmers and NGOs to support better vulnerability reducing practices.

Water Resources

The State Water Policy has been prepared in the State and is being currently revised. In order to provide permanent drinking water supply and to avoid deployment of tankers/tractors, the rehabilitation and source level augmentation of various schemes are being implemented. Through such schemes percolation wells are being developed (6 Nos. along right bank of River Beas and discharge is 30 LPS of each percolation well). The villages/habitations proposed to be covered under these schemes are water scarcity areas and huge number of tankers and tractors are being deployed to supplement the drinking water demand in summer season.

On implementation of such schemes, sufficient drinking water supply is likely to be available to all habitations and maximum number of Panchayats, without the need to deploy tankers/tractors in the summer seasons. Although hand pumps are being installed throughout the State, they do not cover the areas which have no road connectivity.

The demand – driven, and participatory approaches are being adopted in the State on water allocations. The Village Panchayat / community are delegated with powers to plan, implement and manage various schemes.

An integrated approach to water, sanitation & hygiene, ground water conservation and rain water harvesting is being adopted. Capacity development of the community to plan, implement and manage the Rural Water Supply Schemes of their own choice is being undertaken. The Hand Pump programme is quite successful in mitigating the people's misery due to shortage of drinking water in

different pockets of drought prone and acute water scarcity areas.

As towns in the State mostly serve as health resorts, environment improvements assume special significance particularly to avoid pollution of the rivers and other water bodies of the State. To abolish carrying of night soil on head load and scavenging system in the country/states, the Government has given top priority to connect dry latrine system into water pour system. Hence, the sewerage programme has assumed immense importance to contain the water pollution problem.

Under this programme, sewerage facilities are proposed to be provided in all towns of the State. 13 sewerage schemes have been completed viz. Shimla, Palampur, Mandi, Jawalamukhi Shri Naina Devi Ji, Chamba, Bilaspur, Rohroo, Ghumarwin, Manali, Jogindernagar, Arki, Rampur, Reckong-Peo, and Sarahan. The work on 24 schemes is in progress viz., Una, Solan, Sundernagar, Paonta, Sarkaghat, Kullu, Mehatpur, Santokhgarh, Dalhousie, Chowari, Bhuntar, Dharamsala, Hamirpur, Kangra, Nagrota, Jubbal, Sujampur, Nadaun, Kotkhai, Narkanda, Theog, Nurpur, Suni, and Dehra.

The non-conventional methods for utilization of water, including inter-basin transfers, artificial recharge of groundwater, as well as traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting, are being practiced to increase the utilizable water resources. The rain water harvesting has been made mandatory in Himachal Pradesh.

Forests and biodiversity

India has a strong and well-diversified afforestation programme. The impetus to afforestation process was accelerated by the enactment of the Forest Conservation Act, 1980, which aimed at stopping the clearing and degradation of forests through a strict, centralized control of the rights to use forest land and mandatory requirements of compensatory afforestation in case of any diversion of forest land for any non-forestry purposes.

The State of Himachal Pradesh is known for its forest wealth and has demonstrated its commitment to afforestation with an increase in open forest of 13 sq. kms. Traditional methods are promoted for conservation of bio resources.

There are a total of 12 districts in Himachal Pradesh in which, each district having one KVK (2 in Lahaul and Spiti district) do the extension services for helping the farmers in a better way. The priority areas in Himachal Pradesh include diversification of area from traditional crops to commercial crops, development of rain-fed areas through watershed approach, rainwater, increase in maize productivity through high yielding hybrids, adoption of precision farming practices (Poly Houses and Micro Irrigation), organic Farming, etc.

Different agriculture extension services in Himachal Pradesh-

Public Sector Agriculture Extension Services

From the early 1950s, India has witnessed a long history of planned agriculture extension service (AES) intervention. The Government's Community Development Programme (1952) and National Extension Service (1953) were the first attempts to educate farmers about improved methods of farming. The other important area-based special programmes and Farmers' Training Centres were created to educate farmers about high yielding varieties and train them in improved methods of farming to augment the above programmes.



World Bank T & V System

To bring reform in the system of public extension, World Bank's Training & Visiting (T&V) program was introduced as a pilot programme in Rajasthan in 1974, and by 1977 it was scaled up to several states (Ameur, 1994). Under T&V, agriculture extension was expected to act as a 'transmission belt' between agricultural research centres and farmers (Picciotto and Anderson, 1997) by recruiting, training and deploying large and dedicated cadre of technical workers with formal training in agriculture technology.

Since T & V programme was funded by the World Bank, sustainability of funding was the main issue. Further, high requirement and quality of staffs became other major concerns (Babu et. al, 2013 and others) which causes weakened system in several parts of the country, mostly in the central and eastern states, where agricultural growth diminished for a variety of reasons through the 1990s.

A. Agriculture Technology Management Agency (ATMA)

The Indian Government (1998), with the help of the World Bank, introduced the Agriculture Technology Management Agency (ATMA) under the Innovation in Technology Dissemination (ITD) component of the National Agricultural Technology Project (NATP). Firstly, it was introduced in 28 districts in

seven states from 1998 to 2003 under the guidance of MANAGE (National Institute of Agricultural Extension Management), an institution promoted by Ministry of Agriculture, Government of India. It was later expanded throughout the country in 2005 (Babu et al, 2013).

ATMA created a platform for convergence of human and financial resources available in the government, civil society, farm community, and the private sector. ATMA Governing board at the state level set out the priorities for research and extension which is to be implemented in each district.

After the Strategic Research Extension Plan (SREP) was approved, the Farm Information and Advisory Centres (FIAC) at the district level, the block level teams (BTT) and the farmer advisory committee (FAC) were responsible for the extension activities in the district. Existing extension staff still formed the backbone of the ATMA approach. Some additional resources were made available to support innovative approaches, pilots by NGOs, private sector, etc. At the state level, an apex planning and training body, the State Agricultural Management and Extension Training Institute (SAMETI) was established, with the aim of training various levels of extension staff in the convergence-led approach of ATMA.

In Himachal, ATMA runs in 4 districts namely Shimla, Kangra, Hamirpur, and Bilaspur which involve in different agricultural activities for sustainable agriculture development.

B. National Mission on Agriculture Extension and Technology (NMAET)

The National Mission on Agriculture Extension and Technology (NMAET) was launched by the Department of Agriculture Cooperation and Farmers' Welfare (DACFW) in 2014-15 and takes a holistic view of extension by embedding components for technical support and training. It aims to make the system farmer-driven and accountable by restructuring and strengthening existing agriculture extension programmes to enable the delivery of technology and to improve the current agronomic practices of farmers.

In central level, different programmes were introduced with the objective of strengthening the extension machinery and utilizing it for synergizing the interventions under the ATMA. The programmes include- Support to state extension programme for extension reforms (ATMA), sub mission on seed and planting material (SMSP), sub mission on agricultural mechanization (SMAM), sub mission on plant protection and plant quarantine (SMPP).

Other Public Agriculture Extension system

A. Krishi Vigyan Kendras

KVK was launched in 1974 and has grown into 706 centres by the end of 2018, ensuring at least one KVK in each district of the country. Besides research, these institutions also conduct farmer outreach programmes through onfarm demonstration plots, training etc with the main motive of reaching

out to a large numbers of farmers who face severe challenges in terms of capacity, performance standards, and accountability.

In Himachal, the 13 KVKs which have been setup in 12 districts come under ATARI (zone I) which are hosted by Ch. Sarwan Kumar Krishi Vishwavidyalaya, Palampur; and Dr. Y. S Parmar University of Horticulture & Forestry, Solan (Nauni).



B. ATIC (Agricultural Technology Information Centre)

The Agricultural Technology Information Centre (ATIC) is a “single window” support system linking the various units of a research institution with intermediary users and end users (farmers) in decision making and problem solving exercise.

Services provided by ATIC

1. Diagnostic services for soil and water testing, plant and livestock health;
2. Supply research products such as seeds and other planting materials, poultry strains, livestock breeds, fish seed, processed products, etc, emerging from the institution for testing and adaptation;
3. Sale of publications and communication materials as well as audio-visual aids produced by the research organizations.

Table 3: List of ATIC in Himachal Pradesh

-
1. Agricultural Technology Information Centre (ATIC), Directorate of Extension Education, Himachal Pradesh Krishi Vishwa Vidyalaya (HPKVV), Palampur - 176062, Himachal Pradesh
 2. Agricultural Technology Information Centre (ATIC), Directorate of Extension Education, Dr Y.S.Parmar University of Horticulture & Forestry (YSPUHF), Nauni, Solan - 173 230, Himachal Pradesh
 3. Agricultural Technology Information Centre (ATIC), Central Potato Research Institute (CPRI), Shimla - 171 001, Himachal Pradesh
-

C. State Agricultural Universities

With the main mandate of giving formal degree programmes in major agricultural disciplines, SAUs also provide extension and training support through the Directorate of Extension and Education. The information flow is mainly from the universities to the KVKs which are responsible for training farmers.

In Himachal, two universities namely, Ch. Sarwan Kumar Krishi Vishwavidyalaya, Palampur and Dr. Y. S Parmar University of Horticulture & Forestry, Solan (Nauni) were established to provide extension and training support.



D. ICT (Information and Communication Technology) led Extension

ICT has significant potential to reach large numbers of farmers in a cost-effective manner and facilitate two way information flows between farmers and the extension agencies. Scheme launched under ICTs include farmers' portal, mKisan, Kisan Call Centre, Kisan TV Channel, etc.

In Himachal, Doordarshan in Shimla is telecasting Krishi Darshan programme between 6:00 PM to 6:30 PM five days in a week. All India Radio station is also running in Himachal. Presently, for half an hour, Kisan Vani programme is being broadcast, six days a week from FM Dharamshala and Hamirpur.

E. Agri-Clinic and Agri-Business Centres (AC & ABC)

The AC & ABC scheme was launched in 2002 and was targeted at young rural agriculture graduates who wanted to turn entrepreneurs seeking to provide fee-based agriculture services to farmers. A mandatory 45 days training at the Nodal Training Institutes of the National Institute of Agricultural Extension Management (MANAGE), Hyderabad was designed to know the basis of business management among aspiring agriculture entrepreneurs. (MANAGE, <http://www.agriclinics.net/>).

In Himachal, institutes viz., Dr. Y. S Parmar University of Horticulture and Forestry, Indian Society of Agribusiness Professionals (ISAP) and Himachal Consultancy Organization Ltd (Himcon) were organizing different training programmes under Agri-Clinic and Agri-Business Centres Scheme.

F. Agriculture Fairs and Exhibitions

These events have become a common feature in most States and are often effective in demonstrating new technologies and products.

Different trade shows, fairs, etc; are organized in Himachal Pradesh which makes their culture very rich and different from other states. Such shows are mainly celebrated on the occasion of seasonal change for trade purposes in many villages.

G. Community Radio Stations

Community Radio Stations are narrow broadcast channels which seek to generate locally relevant content and advice within a small area and an effective means to disseminate local knowledge and good practices. They help to present success stories and mix entertainment, news, and other non-technical content along with their core mandate of agriculture extension.

In Himachal, two community radio stations namely, Hamara MCPICM 90.4 MHz in Solan, and Tashi Delek 90.4 FM in Kangra encourage the community members to participate in the radio by inviting them to speak on some issues and in getting feedback from the community.

Private Agriculture Extension System

Some private sector agribusiness and input manufacturing companies undertake direct extension activities which help the farmers to realize higher production (and thus returns) through necessary pre-sowing preparation, optimum seed rate, correct agronomic practices, application of nutrients and harvesting techniques.

In the case of different fertiliser companies, different extension activities include a wider range of interventions, such as conducting farmer meetings, organizing crop seminars, arranging soil testing facilities, adopting villages, etc. The growing importance of private sector in both research and extension in India gives rise to an important aspect.

Many companies are operating in the area of agriculture in Himachal Pradesh. Presently, many companies namely Jai mata dee nature fresh private limited, Kangra agro producer company



limited, Himganic farmers producer company limited, green him food processing private limited, CBD Biomedica (India) private limited, Seraj agrocare private limited, Himagri vision producer company limited, Himmap herbals private limited and Bushahr farmers producer company limited are incorporated in 2019.

Agriculture Extension System by NGOs

In India, thousands of NGOs are actively involved in development of rural areas. Their grassroots orientation and proclivity to work in rain-fed and tribal regions has naturally oriented them towards land based livelihood. These organizations working across different places mainly specialize in the field of agriculture, watershed development, natural resource management, livelihood improvement, women empowerment, institutional development etc. (Sulaiman, 2012).

Many NGOs are running in Himachal Pradesh regarding agriculture, out of which eight NGOs come under the state centre on climate change which help people to understand climate change and its impacts on Himalayan eco systems by developing and implementing mountain specific adaptation plans based on vulnerability, risk scenario, and by enhancing capacity to all stakeholders to combat the threat of climate change.

Agriculture Extension System through Farmer Interest Groups/ Farmer producer Groups/ Women farmer Groups etc.

Organized user groups such as commodity groups, farmer interest groups, farmer clubs, women's farmer groups, special interest groups etc. also play small but important roles in extension in niche regions and areas.

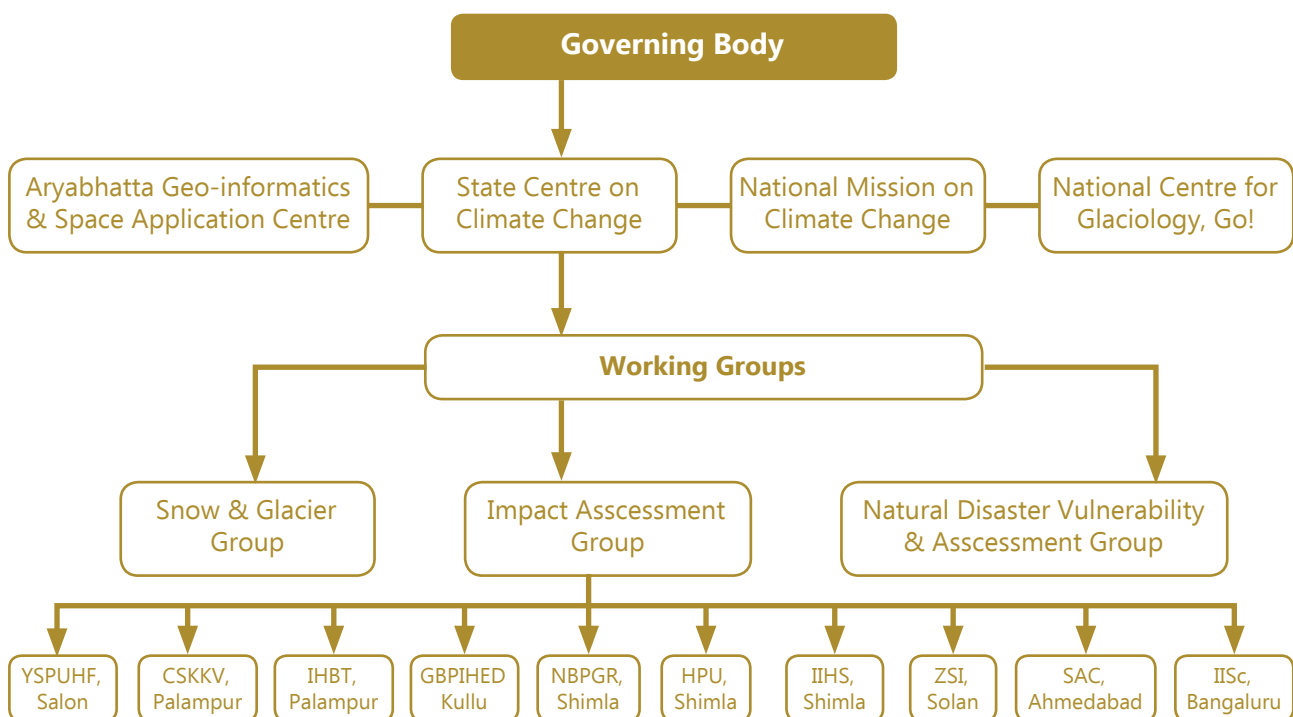
In Himachal, Agriculture Training Centre Mashobra Shimla-7 was identified to be strengthened and upgraded as SAMETI under NATP which caters to the training needs on various aspects of capacity building with more emphasis on management aspects viz., participatory methodology, team building, etc. than the technological aspects. During 2017-18, many achievements were met by giving training regarding orientation and capacity building of ATMA stakeholders, women empowerment, workshops, off-campus programmes, etc. Trainings are mainly organized by Farmers' Training Centres, Dharamsala, Training program organized by universities, Department of Ayurveda, etc. At present, the emphasis is to impart training on stress management, gender sensitization and ITK's in sustainable agriculture.

Agriculture Extension System through Media and ICT

Due to wide availability of ICTs such as mobile phones, internet, television, etc. digital technology has shown a tremendous potential to disseminate information to the farmers and promote extension. In Himachal, e-portal like AGMARKNET is currently running to provide services related to agriculture extension.

Considering the sensitivity of the state towards the vagaries of nature and changing climate, a State Centre has been set up to understand the dynamics of climate change and to evolve management measures with the active involvement of experts such as glaciologist, climatologist, agriculturist, horticulturist, foresters, social scientist etc. This centre also takes up community based management of micro ecosystem for ensuring the stability of the fragile watersheds of the state of Himachal Pradesh (www.hpccc.gov).

Institutional mechanism of State Center on Climate Change (under aegis of the State Council for Science Technology & Environment Himachal Pradesh)



Current climate change scenario of Himachal Pradesh-

- Rise in temperature in the NW Himalayan region by about 1.60C in the last century (Bhutiyani et.al. 2007).
- Warming rate of Shimla was higher than Leh & Srinagar during the period from 1991-2002 as compared to the earlier decades; the gross rise in the mean air temperature during 1980-2002 periods in north western Himalayas as a whole was about 2.20C. (Bhutiyani et.al. 2007)
- It was observed that climate change and precipitation variation in the NW Himalaya based on precipitation data from 1866-2006, caused no change in winter precipitation but a significant decreasing trend in the monsoon precipitation was recorded. (Bhutiyani et.al. 2009)
- In Shimla and Solan, the total snowfall received during 1973-75 period was 190.53 cm which in 1981-85 increased to 827.38 cm. It declined to 101.9 cm in 1986-1990 and further reduced to 78 cm in 2006-07, and it was only 15 cm in the year 2009 (Verma et.al., 2009).
- The decreasing trend in seasonal snowfall at Shimla is very conspicuous since 1990 and it was lowest in 2009 (Verma et.al., 2009).

- It was observed in the Baspa, a tributary of the Satluj river, that due to warmer winters, melting and retreat of snow cover was recorded even in the months of Dec. and Jan. at an altitude of 5400 mts above sea level. The average stream run-off of Baspa river in the month of Dec. from 1966-1992 had increased by almost 75%. The steady rise in the stream run-off of Baspa from 1980 onwards matches with the average global temperature rise during the same period (Kulkarni et.al., 2004).
- The population of light demanding species like Dalbergia sisoo and Acacia nilotica in sub tropical areas will decline on account of non-availability of adequate light during winter and prevalence of cold waves at the time of emergence of new leaves (Verma, 2006, 2010)
- The proportion of climax species-Quercus will decrease and that of conifers will increase. (Verma, 2006, 2010).

Table 4: Post Monsoon Seasons Rainfall Data for the period (October - December 2018)

| District | Actual (mm) | Normal (mm) | Excess of Deficient | |
|----------------|-------------|-------------|---------------------|---------------|
| | | | Total (mm) | %age |
| Bilaspur | 40 | 70 | (-) 30 | (-) 43 |
| Chamba | 88 | 127 | (-) 39 | (-) 31 |
| Hamirpur | 34 | 86 | (-) 52 | (-) 61 |
| Kangra | 40 | 105 | (-) 64 | (-) 61 |
| Kinnaur | 49 | 102 | (-) 53 | (-) 52 |
| Kullu | 110 | 98 | 12 | 12 |
| L/Spiti | 61 | 144 | (-) 82 | (-) 57 |
| Mandi | 50 | 81 | (-) 30 | (-) 38 |
| Shimla | 52 | 75 | (-) 23 | (-) 31 |
| Sirmaur | 35 | 87 | (-) 52 | (-) 60 |
| Solan | 48 | 89 | (-) 41 | (-) 46 |
| Una | 19 | 72 | (-) 52 | (-) 73 |
| Average | 56 | 108 | (-) 52 | (-) 48 |

Note: Normal = -19% to + 19%
 Excess = 20% and above
 Deficiien = -20% to -59%
 Scanty = -60% to -99%

Mission under National Action Plan in Climate Change (NAPCC)

1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Mission on Sustainable Habitat
4. National Water Mission
5. National Mission for Sustaining the Himalayan Ecosystem
6. National Mission for Green India
7. National Mission for Sustainable Agriculture
8. National Mission on Strategic Knowledge for Climate Change

Projects sanctioned under National Adaptation Fund for Climate Change (NAFCC) in Himachal Pradesh

Sustainable livelihoods of Agricultural-dependent rural communities in drought prone districts of Himachal Pradesh through climate smart solutions under the department of Environment, Science and Technology, Government of H.P.

Indian Council of Forestry Research and Education (ICFRE)

ICFRE is the largest organization responsible for forestry research in India. ICFRE was created in 1987, under the Central Ministry of Environment and Forests (India), to direct and manage research and education in forestry sector in India. ICFRE is headed by a Director General with headquarters at Dehradun. ICFRE became an autonomous council under the Ministry in 1991. Different research institutes related to ICFRE are located in many parts of the country.

In Himachal, HFRI (Himalayan Forestry Research Institute) is located in Shimla, Himachal Pradesh to organize, direct and manage research in forestry sector.

Selection of area

There are four agro climatic zones in Himachal Pradesh viz. Shivalik Hill Zone, Mid Hill Zone, High Hill Zone and Cold Dry Zone.

1. Shivalik Hill Zone (Sub Tropical, Sub Mountain and Low Hills): It covers the district of Una, Bilaspur, parts of Sirmour, Kangra, Chamba and Solan. Major sources of irrigation are wells and tubewells. The major crops grown in this Zone are Wheat, Maize, Paddy, Black Gram, Sugarcane, Mustard, Potato, Vegetables, Pulses and Barley.

2. Mid Hill Zone (Sub Humid Mid Hills): It comprises major parts of Mandi and Solan districts and parts of Hamirpur, Kangra (Palampur and Kangra tehsil), Shimla (Rampur tehsil), Kullu, Chamba and Sirmour districts. Major sources of irrigation are Kuhls and tubewells. The major crops are Wheat, Maize, Paddy, Black Gram, Barley and Beans, Pulses and Forages, etc., and the zone has very good potential for the cultivation of cash crops like off-season Vegetables, Ginger and production of quality seeds of temperate vegetables like cauliflower and root crops.

3. High Hill Zone (wet temperate high hills): This zone includes major parts of Shimla (except Rampur tehsil), Kullu District and parts of Solan, Mandi, Chamba, Kangra and Sirmour district with an altitude 1800m above mean sea level. Major sources of irrigation are Kuhls and storage tanks. The commonly grown crops are Wheat, Barley, Lesser Millets, Pseudo- cereals (Buckwheat and Amaranthus), Maize, Rice and Potato, etc. The area is ideally suited to the production of quality seed potato and temperate vegetables.

4.Cold Dry Zone (dry temperate high hills): Covers the districts of Kinnaur and Lahual-Spiti and parts of Chamba district with altitude exceeding 2200m above mean sea level.The Kuhl is the single source of irrigation. The major crops grown are Wheat, Barley, Rajmash, Pseudo cereals like Buckwheat, Amaranthus. It is ideally suited for the production of quality seed potato, temperate and European type of vegetables and their seeds, seed potato and pea's seed.

Considering the objectives of the study, the entire four zones were selected to assess the impact, resilient practices, and role of different extension services to climate change adaptation in Himachal Pradesh. From each zone, one district (Kangra district from Shivalik zone, Mandi district from Mid Hill Zone, Shimla district from High Hill Zone and Kinnaur district from cold dry zone) were selected.

Himachal Pradesh is predominantly an agricultural State where Agriculture, Horticulture, Fisheries and Animal Husbandry provide direct employment to about 71 percent of the total population. The Agriculture Sector contributes nearly 30 percent of the total state domestic product. These departments are dedicated to serve the farming community by implementing various Developmental Programmes and disseminating the relevant technology to increase productivity, production, and profitability of field crops. The natural endowments like soil, land, water, etc. are being harnessed in such a way that cherished goals of ecological sustainability, economic upliftment of farming community are achieved. About 18-20% area is irrigated and the rest is rain-fed.

Department of Agriculture

The Department of Agriculture was established in the year 1948. In 1950, it was merged with the Forest Department. The Department started functioning independently in the year 1952. In 1970, Horticulture was carved out of the Department of Agriculture and separate a Department of Horticulture was established. Agriculture research was also transferred from the Agriculture Department and assigned to erstwhile Agriculture Complex, presently the Agriculture University, Palampur. The Department of Agriculture is therefore now concentrating on agriculture production and soil water conservation.

Services to Farmers (H.P, Econ survey 2018-19)-

A. High Yielding Varieties Programme

There are 20 Seed Multiplication Farms from where foundation seed is distributed to registered farmers. In addition, there are 3 Vegetable Development Stations, 12 Potato Development Stations and 1 Ginger Development Station in the State.

Table 5: Area Brought Under High Yielding Varieties (000 Hect.)

| Year | Malze | Paddy | Wheat |
|--------------------|--------|-------|--------|
| 2016-17 | 196.94 | 62.76 | 321.37 |
| 2017 - 18 (Target) | 206.00 | 65.00 | 342.00 |
| 2018 - 19 (Target) | 205.00 | 63.00 | 330.00 |
| 2019 - 20 (Target) | 203.00 | 62.90 | 323.00 |

B. Plant Protection Programme

In order to increase the production of crops, adoption of plant protection measures is of paramount importance. During every season, campaigns are organized to fight the menace of crop disease, insects and pests, etc. The Scheduled Castes/ Scheduled Tribes, IRDP families' farmers of Backward Areas, and small and marginal farmers are provided plant protection chemicals and equipments at 50 percent of the original cost. It is the approach of the Department to reduce consumption of Plant Protection Chemicals by gradually switching to Biological control of pests/diseases.

Table 6: Achievement and Targets proposed

| Year | Coverage of area under plant protection measures (000 Hect.) | Distributin of Chemicals (M.T.) |
|--------------------------------------|---|--|
| 2012-17 (12th Five Year Plan Target) | 425.00 | 600.00 |
| 2012 -13 | 92.00 | 161.19 |
| 2013 - 14 | 120.51 | 210.90 |
| 2014 - 15 | 108.63 | 190.11 |
| 2015 - 16 | 105.94 | 185.40 |
| 2016 - 17 | 111.58 | 205.78 |
| 2017 - 18 | 103.26 | 180.71 |
| 2018 - 19 (Target) | 77.14 | 135.00 |

C. Soil Testing Programme

In order to maintain the fertility of the soil during each crop season, soil samples are collected from the farmers' fields and analysed in the soil testing laboratories. Soil testing laboratories have been established in all the districts (except Lahaul and Spiti).

These laboratories have been strengthened with latest equipments. At present, eleven (11) soil testing labs have been strengthened. Nine (9) mobile labs and forty seven (47) mini labs have also been setup by the department. Soil testing service has also being included under H.P. Govt. Public Service Act, 2011 in which the soil health cards are being made available to the Farmers through online service within a prescribed time limit.

D. Prakritik Kheti Khushal Kisan Yogna under Zero Budget Natural farming

The State Government has launched new scheme "Prakritik Kheti Khushal Kisan Yogna" in the state. The Government intends to encourage "Zero Budget Natural Farming", so as to bring down the cost of cultivation. The use of chemical fertilizers and chemical pesticides will be discouraged. The budget provided for pesticides/ insecticides to the department of Agriculture and Horticulture will be used for providing bio-pesticides and bio insecticides.

E. Bio-Gas Development programme

Keeping in view the depleting sources of conventional fuel i.e. firewood, biogas plants have assumed great importance in the low and mid hills in the State. Till March, 2017 since inception, 44,815 bio-gas plants have been installed in the State. During 2017-18, 37 biogas plants were installed in the state. This programme has been transferred to the department of Rural Development, Himachal Pradesh for its implementation in the year 2018-19.

F. Fertilizer Consumption and Subsidy

Fertilizer which helps in increasing the production to a great extent is a critical input. The level of fertilizer consumption in 1985-86 was 23,664 M.T. which increased to 57,560 M.T. in 2017-18.

In order to promote balanced use of chemical fertilizers, a subsidy of `1,000 per MT on complex fertilizers have been allowed. Use of water soluble fertilizers is promoted in a big way for which subsidy has been allowed to an extent of 25 percent of cost. The subsidy is being provided under the Plan schemes. About 51,500 M.T. of fertilizers in terms of nutrients are proposed to be distributed during 2018-19.

G. Agriculture Credit

Traditionally, non-institutional sources of finance have been the major source of finance for the rural households due to various socio-economic conditions. Some of them have been lending at exorbitant rates of interest. As the poor own few assets, it is unviable for the financial institutions to secure their lending with collateral.

However, the Government has taken measures to ensure timely and adequate supply of institutional credit to the rural households at reasonable rate of interest. In view of the propensity of the farmers to borrow money, most of whom are marginal and small farmers, credit flow for purchase of input is being made available by the banks.

Institutional credit is being extensively disbursed but there is scope to increase the same particularly in respect of the crops for which insurance cover is available. Providing better access to institutional credit for small and marginal farmers and other weaker sections to enable them to adopt modern technology and improved agricultural practices has been one of the major objectives of the Government. The banking sector prepares crop specific credit plans and the credit flow is monitored urgently in the meetings of the State level Bankers' Committee.

H. Crop Insurance Scheme

Pradhan Mantri Fasal Bima Yojna (PMFBY) was launched in the state during the Kharif, 2016 season as per the administrative approval and operational guidelines issued by the Department of Agriculture, Ministry of Agriculture, Government of India. In this insurance scheme, Maize and Paddy crops have

been covered during Kharif season. The different stages of risk leading to crop loss due to preventing sowing, post harvest losses, localized calamities and losses to standing crops (from sowing to harvest) have been covered under this new scheme. The scheme is compulsory for the borrower(farmers) availing Seasonal Agricultural Operational (SAO) crop loans for the insurable crops from the Banks and Primary Agricultural Cooperative Societies (PACs), and optional for the non-loan farmers. Under PMFBY, claims beyond 350 percent of premium collected or percentage of claims to sum insured exceeds 35 percent whichever is higher at the National level, of all the companies combined, and shall be paid by Center and State equally.

The Government of India, through the Ministry of Agriculture has launched another Crop Insurance Scheme from Kharif, 2016 season called "Restructured Weather Based Crop Insurance Scheme (R-WBCIS). The scheme intends to provide insurance protection to the cultivators against Natural Calamities which are deemed to adversely affect the Kharif crops during its cultivation period.

I. Seed Certification Programme

Agro-climatic conditions in the State are quite conducive for seed production. In order to maintain the quality of the seeds and also ensure higher prices of seeds to the growers, Seed certification programme has been given due emphasis. Himachal Pradesh State Seed Certification Agency registered growers in different parts of the State for seed production and certification of their produce.

J. Agriculture Marketing

For the regulation of agricultural produce in the State, Himachal Pradesh Agricultural/ Horticulture Produce Marketing Act, 2005 has been enforced. Under the Act, Himachal Pradesh Marketing Board has been established at the State level.

The whole of H.P. has been divided into ten notified market areas. Its main objective is to safeguard the interest of the farming community. The regulated markets established in different parts of the state are providing useful services to the farmers.

A modernized market complex at Solan is functional for marketing of agricultural produce, besides construction of market yards in different area.

At present, 10 market committees are functioning and 58 markets have been made functional. Market information is being disseminated through different media i.e. AIR Doordarshan, Print Media and through internet to farmers.

The work of development of marketing infrastructure is done out of the funds of APMCs. Information on daily market rates is also disseminated through AIR/ Doordarshan. Market rates of 39 commodities are also disseminated through agmarknet.nic.in. The APMC act has been repeated as per the model act and provision has been made for private markets, single point market fee, contract farming etc.



K. Agriculture Mechanization

Under this scheme, new farm implements/ machines are popularized among the farmers. Testing of new machines is also done under this programme. The department proposes to popularize small power tillers and implements suited to hilly conditions.

L. Soil and Water Conservation

Soil is subject to splash, sheet and gully erosion resulting into degradation of the soil. Besides this there is biotic pressure on the land. To curb this menace particularly on the agriculture lands, the Department is implementing two soil and water conservation schemes under state sector. The schemes are:-

- 1) Soil Conservation Works
- 2) Water conservation and development

Water conservation and minor irrigation programme has been accorded priority in order to boost agriculture production. The Department has prepared a plan to harvest rain water by constructing tanks, Ponds, check-dams and storage structures. Besides this, low lifting water devices and efficient irrigation system through sprinklers are also being popularized. In these projects, major thrust would be on soil and water conservation, and creation of employment opportunities at the farm level.

M. Dr.Y.S.Parmar Kisan Swarozgar Yojna

In order to achieve faster and more inclusive growth in the agriculture sector, the Government of Himachal Pradesh has started "Dr.Y.S.Parmar Kisan Swarozgar Yojna." (Poly house and micro irrigation inside polyhouse). Project components include creation of need based infrastructure and are expected to fulfil the objectives of high productivity, quality, safeguard against adverse weather, efficient input use, etc. Project components include construction of location specific models of poly houses with micro irrigation facility. For this, 85 percent project assistance is provided to the farmers. Also, for creation of water sources individually and collectively by a group of farmers, (low/ medium lift, pumping machinery) 50 percent subsidy is provided.

Table 7: Project Components (2014 - 15 to 2018 - 19)

| S. No. | Component | Nos./Cost | Covered area |
|---------------|--|------------------|---------------------|
| 1. | Poly House Framed Structure | 4,700 | 8,35,350 Sqm. |
| 2. | Micro Irrigation (sprinkle/ Drip System Poly Houses as per feasibility) | 2,150 | 8,20,050 Sqm. |
| 3. | Low lift medium lifts and pumping machinery 1 HP with poly houses as per feasibility | 870 | - |
| 4. | Total cost of civil works | 10,178.10 Lakh | - |
| 5. | Farmers Sensitization contingency and cost escalation | 940.45 lakh | - |
| 6. | Total Project Cost | 1,11,18.55 Lakh | - |

N. Rashtriya Krishi Vikas Yojna

Rashtriya Krishi Vikas Yojna –RAFTAAR was initiated in 2007 as an umbrella scheme for ensuring holistic development of agriculture and allied sector. The scheme was implemented as an Additional Central Assistance (100%) from GOI. The funding pattern has been altered in the ratio of 90:10 for North Eastern/Himalayan States from 2015-16 onwards. Now RKVY has been revamped as RKVY-RAFTAAR Remunerative Approaches for Agriculture and Allied sector Rejuvenation for the remaining period of the Fourteenth Finance Commission.

O. National Mission on Agricultural Extension and Technology (NMAET)

National Mission on Agricultural Extension and Technology (NMAET) has been launched to make the extension system farmer-driven and farmer arrangement of technology dissemination. NMAET has been divided into Four Sub-Missions:- 1. Sub Mission on Agriculture Extension (SAME):- 2. Sub Mission on Seed and Planting Material (SMSP):- 3. Sub Mission on Agriculture Mechanization (SMAM):- 4. Sub Mission on Plant Protection and Plant Quarantine (SMPP).

P. National Food Security Mission (NFSM)

The National Food Security Mission (NFSM) is aimed at enhancing the production of Rice, Wheat and Pulses. NFSM has been launched in the State from Rabi 2012 with two major components viz. NFSM-Rice and NFSM-Wheat. Under NFSM-Rice, it is in operation in three districts of the state, whereas, NFSM-Wheat in nine with 100 percent assistance from the Central Government. The aim of this mission is to increase production of rice and wheat through area expansion and productivity enhancement, restoring soil fertility and productivity, creating employment opportunities, and enhancing the level of farm economy in targeted districts.

Q. Pradhan Mantri Krishi Sinchai Yojana

In an attempt to improve the Agricultural productivity, the government of India has started a new

scheme, viz. Pradhan Mantri Krishi Sinchai Yojana (PMKSY). Micro irrigation projects (“Har Khet Ko Pani”) and end-to-end irrigation solutions will be the key focus of this scheme. “The major objective of the PMKSY is to achieve convergence of investments in irrigation at the field level, expand cultivable area under assured irrigation, improve on-farm water use efficiency to reduce wastage of water, enhance adoption of precision-irrigation and other water-saving technologies”.

Under this scheme, a budget provision of -22.00 crore has been proposed for the year 2018-19 under the state plan.

R. Efficient Irrigation through MicroIrrigation Scheme

The State Government is committed to promote Agriculture in the State by increasing the productivity of crops. For efficient system of irrigation, the Government has launched a scheme named Efficient Irrigation through Micro-Irrigation Scheme Systems’.

S. Uttam Chara Utpadan Yojna

With a view to increase fodder production in the state, the state Government has launched a scheme; ‘Uttam Chara Utpadan Yojana’ for fodder development by bringing an area of 25,000 hectare under fodder production. Quality seed of fodder grasses, cuttings, and seedings of improved fodder varieties will be supplied on subsidized rates to the farmers. Subsidy on Chaff Cutters is available to the SC/ ST and BPL farmers.

T. Mukhya Mantri Khet Sanrakshan yojna

Monkeys and wild life menace cause huge loss to crops annually. The present practice of crop protection by manual guarding does not ensure 100 percent crop. Therefore, the Government of Himachal Pradesh has introduced a scheme “Mukhya Mantri khet Sanrakshan Yojna”. Under this scheme, a subsidy of 80 percent will be provided in which fence around the farm will be energized with the help of solar power. Current in the fence around the farms will be sufficient to keep away the stray animals, wild animals and monkeys from the farms. Under this scheme a budget provision of -30.00 crore has been made for the year 2018-19, and about 1,800 hectares of cultivated land shall be fenced and protected from wild/ stray animals and monkeys menace under this scheme.

U. Mukhya Mantri Kisaan Evam Khetihar Mazdoor Jeevan Suraksha Yojna:

With a view to provide insurance cover to the farmers and agricultural labourers in the event of sustaining injury or death due to operation of farm machinery, the State Government has launched a Scheme called; ‘Mukhyamantri Kisaan evam Khetihar Mazdoor Jeevan Surakhsha in 2015-16.

In case of the death and permanent disability, a compensation of -1.50 lakh, and in case of partial special abilities -50,000 will be provided to the affected farmers. A budget provision of -40.00 lakh has been kept for the year 2018-19.

V. Lift Irrigation And Bore well Scheme:

In most parts of the State, water has to be lifted for irrigation purpose. As an incentive to the farmers, the Government has decided to grant 50 per cent subsidy for construction of Lift Irrigation Schemes and installation of Bore-Wells by individual or group of farmers for irrigation purposes. Under this scheme, financial assistance is available for construction of Low & Medium lift irrigation systems, Shallow wells, Shallow Bore Wells, Water Storage tanks of different capacities, Pumping machinery and water Conveyance pipes to individual farmers or a group of farmers. A budget provision of -10.00 crore has been kept for the year 2018-19.

W. Saur Sinchayee Yojna

Solar energy is a renewable energy, alternate source of energy and has a huge potential, which can cater to most of the critical needs of farm operations. It is not only cheap, but also eco-friendly. Solar energy is a an uninterrupted source and all the energy stored in the Earth's reserves like coal, oil and natural gas is equal to the energy in just 20 days of sunshine.

State Government has introduced a new scheme viz, "SAUR SINCHAYEE YOJNA" with a view to provide assured irrigation to crops, enhance the production & productivity where electricity accessibility in remote areas is costly in comparison to Solar PV pumps.

Under this scheme, 90 percent assistance will be provided to small / marginal farmers for the installation of solar pumping machinery on individual basis. 80 percent assistance will be provided to medium / big farmers for the installation of solar pumping machinery on individual basis. 100 percent assistance will be provided if minimum five farmers opted for installation of solar pumping machinery on community basis.

X. Jal Se Krishi Ko Bal Yojna

With a view to provide water for irrigation, the Government has launched a new scheme "Jal Se Krishi KoBal Yojna". Under this scheme, check dams and ponds will be constructed. Farmers can use this water for irrigation purpose after construction of small lifting schemes or Flow Irrigation schemes on individual basis.

The total outlay for this scheme is -250.00 crore for the next Five years. A budget provision of -40.00 crore has been kept for this. Under this scheme, 100 percent expenditure would be borne by the Government for implementation of community based small water saving scheme.

Department of Horticulture

The State Department of Horticulture functions with the objective of building a prosperous Himachal through scientific development of horticulture by harnessing the natural resources for the development of a sustainable system of agriculture in the hilly areas. The Department came into existence in September 1970. The pragmatic policies for the development of horticulture of the State

Government combined with their adoption by the farmers have resulted in the transformation of the horticulture industry of Himachal Pradesh. The State has earned the distinction of being the "Apple State of India".

- a) The rich diversity of agro-climatic conditions, topographical variations and altitudinal differences coupled with fertile, deep, and well-drained soils favour the cultivation of temperate to sub-tropical fruits in Himachal. The region is also suitable for cultivation of ancillary horticultural produce like flowers, mushroom, honey and hops.
- b) This particular suitability of Himachal has resulted in shifting of land use pattern from agriculture to fruit. Apple is so far the most important fruit crop of Himachal Pradesh, which constitutes about 49 percent of the total area under fruit crops and about 79 percent of the total fruit production. The area under apple has increased from 400 hectares in 1950-51 to 3,025 hectares in 1960-61 and 12,634 hectares in 2017-18.
- c) This pace of development is further jeopardized due to the erratic apple production, owing to weather vagaries and market fluctuations. The advent of WTO, GATT and liberalization of the economy is further causing many challenges on the dominance of apple in the fruit industry of Himachal Pradesh. The fluctuation in the production of apple during the last few years has attracted the attention of the government. It is necessary to explore and harness the vast horticulture potential of the hill State through diversified horticulture production in varied agro-ecological zones.
- d) Horticulture Development scheme is the major programme aiming at the creation and maintenance of infrastructural facilities in the rural areas for ensuring equitable access to the resources and inputs required for the promotion of all fruit crops. Under this scheme, the programmes like development of fruit production, area expansion programme, and demonstration of new technologies and improved package of practices on the orchards of fruit growers, development of Walnut/ Hazelnut / Pistachio nut, mango / litchi, strawberry and olive are being implemented. During the year 2018-19 for promotion of mechanized farming, 1,173 Nos. of Power Sprayers, and 1,808 Nos. of Power Tiller (8BHP) were distributed on Subsidy basis among the orchardist under Horticulture Development Scheme.
- e) The fruit producers should get better price of their produce, therefore, Marketing Intervention Scheme is being implemented in the State. Under this scheme, during the year 2018-19, the procurement price of Apple remained same as the previous year i.e.,- 7.50 per Kg and 20 per Kg which was fixed for Lahaul Spiti District as a special case, keeping in view the heavy losses which occurred due to heavy snow fall during the last week of November 2018.
- f) To promote flower cultivation, two Tissue Culture Laboratories have been established under Model Flower Cultivation Centres at Mahogbagh (Chail, District Solan) and Palampur District Kangra. Four Farmers' Cooperative Societies are functioning for the production and marketing of

flowers in district Shimla, Kangra, Lahaul and Spiti and Chamba. Ancillary horticultural activities like mushroom and Bee keeping are also being promoted.

In the year 2018-19, upto December 2018, 361.47 MT of pasteurized compost for mushroom was prepared and distributed from the department units located at Chambaghat, Bajoura and Palampur.

- g) For providing employment to the skilled and unskilled unemployed youth and promoting Commercial Floriculture Farming in the state, funds have been allocated under 'Himachal Pushp Kranti Yojna' amounting to `10.00 crore during the year 2018-19.

Similarly, to produce quality fruit crops and increasing production, to increase honey production and other bee products, to provide employment opportunity to the unemployed rural/urban youths as a source of their livelihood, funds have been allocated under 'Mukhya Mantri Madhu Vikas Yojna' amounting to `10.00 crore during the year 2018-19.

Himachal Pradesh Marketing Corporation (HPMC)

H.P.M.C. a State public undertaking was established in the Pradesh with the objective of marketing fresh fruits and vegetables, processing the unmarketable surplus and marketing the processed products. Since its inception, HPMC has been playing pivotal role in the life of fruit growers of the state by providing them remunerative returns of their produce.

Department of Fisheries

In pursuance to a recommendation made by Fisheries Development Advisor to Government of India, the Fisheries Department in Himachal Pradesh was created during August 1950 as a wing of Forest Department headed by Deputy Warden of Fisheries.

The main activities envisaged for the department was conservation of riverine fisheries, production and protection of sport fisheries, issuing of licenses, breeding and production of trout seed, their plantation in rivers & streams for augmentation of riverine stock.

Commercial trout farming which was a distant dream in early eighties became a reality when the technology was disseminated to the rural youths of Kullu, Mandi, Chamba and Shimla districts. Himachal became the first state to popularize the trout farming in the private sector.

The Fisheries Department has been set up with the following mandate:

1. To increase fish production in the State by judicious management of all the culturable water resources.
2. To develop reservoir fishery of the State with an aim to increase per hectare production from the open impoundments.
3. To undertake breeding programme of Indian and exotic Carps, Mahseer, Trouts and other sub-

temperate species for augmenting the seed stocking programme in reservoirs, river and streams and tributaries.

4. To protect and conserve reservoir and lacustrine fisheries resources of the state.
5. To promote game fishery in the state with particular emphasis on promotion of Tourism.
6. To promote commercial farming of Rainbow Trout in the high altitude areas.
7. To promote aquaculture in the state by providing technical and financial assistance to the fishermen and rural youths.
8. To generate employment opportunities in the fishery sector and ameliorating the condition of fishermen of the state.

The Department of Fisheries has constructed carp as well as trout seed production farms in the State to cater to the requirement of reservoirs rural ponds and commercial farms in public as well as private sectors.

Table 8: Project Components (2014 - 15 to 2018 - 19)

| S. No. | Name of Scheme | Outlay Amount (in lakh) |
|---------------|---|--------------------------------|
| 1. | Construction of 5.75 ha. fish seed rearing ponds in private sector. | 22.20 |
| 2. | Construction of 10 units of Trout raceways in private sector | 23.40 |
| 3. | Construction of two carp hatchery in private sector | 25.00 |
| 4. | Construction of the one fish landing centre at State Reservoir. | 30.00 |
| Total | | 100.60 |

Department of Animal Husbandry

Animal Husbandry and Dairying activities continue to be an integral part of human life. As a sequel to the age old practices and dependence of population on livestock, Himachal Pradesh is endowed with the large livestock population. According to the 19th livestock census - 2012, the total livestock population of H.P. is 52,11,087 which include 22,64,160 cattle, 7,60,687 buffaloes, 9,01,540 lakh sheep, 12,40,835 goats and 13,199 horses and ponies. The poultry population of the state is 8,08,431.

When Himachal Pradesh came into existence, it had only 9 Veterinary Hospitals and only indigenous animals were being reared.

In 1948, a separate Animal Husbandry Department came into being and programmes for increased milk production and breed improvement were taken in hand in a big way to meet the day to day requirement of increasing human population and to boost the rural economy.

In 1951, up grading programme of cows was started under the All India Key Village Scheme and two key village centres at Kotgarh and Solan were started, where Red Sindhi bulls were located for cross-breeding programme. The impact of this programme was quite encouraging but the coverage was very limited. Subsequently, artificial insemination was started in 1954-55 by transporting Jersey

Semen by air from Bangalore to Himachal Pradesh. During this period, new cattle Breeding farm was started at Kothipura in Bilaspur district and Jersey animals received from Denmark were maintained at this farm where their performance was quite encouraging.

The real breakthrough in the cattle breeding programme was achieved with the implementation of the Indo-New Zealand Livestock Improvement Project under which 175 pure Jersey animals were brought from New Zealand in 1974, which formed the nucleus foundation stock of jersey herd at Palampur in the University campus.

Apart from this, the Frozen Semen Laboratory was also established in collaboration with the New Zealand Government and another with the assistance of the West Germany Government at Bhangrotu, District Mandi during 1974. Both these Laboratories acted as a pace setter for intensifying the A.I. programme in the State.

Table 9: Milk Production and Per Capita Availability

| Year | Milk Production (Lakh Tonnes) | Per Capita Availability |
|-----------------------|-------------------------------|-------------------------|
| 2017 - 18 | 13.92 | 556 |
| 2018 - 19 (Estimated) | 14.71 | 588 |

- a) Under Animal Health and Disease Control, 1 State level Veterinary Hospital, 1 Zonal Hospital, 9 Polyclinics, 60 Sub-Divisional Veterinary Hospitals, 348 Veterinary Hospitals, 30 Central Veterinary Dispensaries and 1,766 Veterinary Dispensaries are in the State as on December, 2018. Besides these, 6 Veterinary Check posts are also operating to provide immediate veterinary aid to the livestock. Under Mukhyamantri Arogya Pashudhan Yojna, 1,251 veterinary dispensaries have been opened as of December, 2018.
- b) For improving the quality of sheep and wool, Government Sheep Breeding Farms at Jeori (Shimla), Sarol (Chamba), Tal (Hamirpur), and Karachham (Kinnaur) are supplying improved sheep to the breeders of the State. One Ram centre at Nagwain in District Mandi is also functioning where improved Rams are reared and supplied to breeders for cross breeding.
- c) Dairy production is an integral part of the Animal Husbandry and forms part of the earning of small and marginal farmers in Himachal Pradesh. The recent trend towards the development of a market oriented economy emphasized the importance of milk production, especially in areas falling in the vicinity of urban consumption centres. This has motivated farmers to replace local nondescript breeds of cows with crossbreed cows. Upgradation of indigenous cattle is being carried out by cross breeding with Jersey and Holsten; buffalo upgradation with Murrah bull is being popularized. Artificial insemination with the latest technology of Deep Frozen Semen is being practiced.
- d) One horse breeding farm at Lari in Lahaul and Spiti district has been established with the objective to preserve Spiti breed of horses. During the year 2018-19 up to December, 2018, 55 horses have

been kept in this farm. One Yak breeding farm has been also established in the premises of horse breeding Lari.

Backyard Poultry Farming

To develop poultry sector in Himachal Pradesh, the department is running the following poultry development schemes especially in rural areas of the State. Under Backyard Poultry Project, 3 week old chicks of coloured Strain variety, i.e. Chabro, are supplied to the farmers of the State and one unit consists of 50-100 chicks. These chicks are produced at the two hatcheries in Nahan and Sundernagar. Assistance to State for Control of Animal Diseases.

Due to large scale interstate migration from adjoining states and lack of nutrition grasses and fodder due to hilly topography, most of the animals are prone to various livestock diseases.

The Central Government has provided assistance to the State Government for control of contagious diseases under ASCAD which is on the pattern of 90 percent Central share and 10 percent State share. Diseases for which free vaccination is being provided to livestock owners are FMD, HSBQ, Enterotoxaemia, PPR, Ranikhet Disease, Marek's disease and Rabies under this project.

BPL Krishak Bakri Palan Yojna

Under this scheme it has been proposed to distribute units of 11 Goats (10 female+1 male), 5 Goats (4 female + 1 male) and 3 Goats (2 female + 1 male) of Beetls Sirohi/ Jamnapari/ white Himalayan breeds respectively on 60 percent subsidy to landless, BPL category farmers to increase their income.

Milk Based Industries

H.P. Milkfed is implementing dairy development activities in the State. The H.P. Milkfed has 977 Milk Producers' Co-operative Societies. The total membership of these societies is 42,650 out of which 205 Women Dairy Co-operatives are also functioning.

The surplus milk from the milk producers is collected by village dairy co-operative societies, processed and marketed by H.P. Milkfed. At present, the Milkfed is running 22 milk chilling centres having a total capacity of 91,500 litres milk per day, and 11 milk processing plants having a total capacity of 1,00,000 litres milk per day. One milk powder plant of 5 metric tonne per day at Duttnagar in Shimla District, and one cattle feed plant of 16 metric tonnes per day capacity at Bhor in Hamirpur District has been established and functioning.

Table 10: Achievement of H. P. Milkfed

| S. No. | Particulars | 2017 - 18 | Upto 30.11.18 |
|--------|--------------------|-----------|---------------|
| 1. | Orgazied Societies | 965 | 977 |

| | | | |
|----|------------------------------|----------|----------|
| 2. | Membership | 42510 | 42650 |
| 3. | Milk Procure (Lakh/ Liter) | 219.00 | 178.68 |
| 4. | Milk Marketing (Lakh/ Liter) | 93.75 | 53.34 |
| 5. | Ghee Sold (MT) | 161.41 | 96.26 |
| 6. | Paneer Sold (MT) | 83.07 | 56.03 |
| 7. | Butter Sold (MT) | 22.02 | 14.72 |
| 8. | Dahi Sold (MT) | 180.76 | 74.21 |
| 9. | Cattle Feed (in qtls.) | 19970.00 | 12976.50 |

Department of Forest and Environment

Forests in Himachal Pradesh cover an area of 37,947 Sq. Km. and account for 68.16 percent of total geographical area of the state. However, at present, 26.4 percent is the forest cover of the total geographical area of the State. The main objective of Himachal Pradesh Forest Policy is the proper utilization of forests, conservation, and extension. The aim of the Forest Department is to enhance the forest cover in the State to 30 percent of its geographical area by 2030 to meet the Sustainable Development Goals (SDGs).

Forest Plantation

Van Mahotsava at State, Circle and Division levels is also celebrated for educating the masses and creating awareness amongst all stakeholders regarding forestry and environmental concerns under New Forestry Scheme (Sanjhi Van Yojana). Another scheme named "Smriti Van Yojana" is also being implemented with the vision to create awareness amongst the people about tree planting.

Intensification of Forest Management Scheme

Forests in the State are subject to increasing biotic pressure due to increase in human population, changing animal husbandry practices, and developmental activities. Forests are exposed to perils of fire, illicit felling, encroachments and other forest offences. Forest Protection is being strengthened by equipping check posts at sensitive places with CCTVs to ensure electronic surveillance to curb forest offences.

Firefighting equipment and improved techniques are also being introduced and made available to all the forest divisions where fire is a major destructive element. Communication network for effective management and protection of forest wealth is very important. Keeping these factors in view, Intensification of Forest Management Scheme implemented with Central Assistance.

Nagar Van Udyan Yojana - “Ek Kadam Hariyali Ki Or”-A Programme for Climate Smart Green Cities

The vision of this scheme is to create at least one City Forest in each city having Municipal Corporation for providing wholesome, healthy living environment and contributing to growth of Smart, Clean, Green, Sustainable and Healthy Cities.

New schemes-

1. Samudayik Van Samvardhan Yojna

The main objective of this scheme is to ensure participation of local communities in conservation & Development of Forests through Plantation, Improving quality of forest and increasing the forest cover. The scheme will be implemented through existing JFMCs/VFDSs.

2. Vidyarthi Van Mittar Yojna

This scheme has been started for the students to sensitize them about the importance of Forests and their role in environmental conservation, to inculcate in students a sense of attachment towards nature conservation, protection of forests and increase the forest cover.

3. Van Samridhi Jan Samridhi Yojna

This scheme has been started to strengthen the NTFP resource base in the state through active community participation and empowerment of local communities in collection, conservation and marketing of NTFPs to augment the incomes of rural population. The scheme will be implemented initially in 7 most biodiversity rich districts namely, Chamba, Kullu, Mandi, Shimla, Sirmour, Kinnaur, and Lahaul & Spiti, and subsequently in the remaining districts of the State.

Externally aided projects-

Himachal Pradesh Forest Ecosystems Climate Proofing Project (K.F.W assisted)

Himachal Pradesh Forest Eco- systems Climate Proofing Project with the assistance of Germany (KfW) Project is being implemented in Chamba and Kangra districts.

Himachal Pradesh Forest Eco systems Management and Livelihood Improvement Project:

A new Project named “Himachal Pradesh Forest Eco systems Management and Livelihood Improvement Project” to be implemented over a span of for 8 years (2018-19 to 2025-26) amounting to `800.00 crore, has been started with the assistance of Japan International Cooperation Agency (J.I.C.A.).The Funding pattern of the project is 80 percent loan and 20 percent State share. The project will be

implemented in Bilaspur, Kullu, Mandi, Shimla, Kinnaur, Lahaul-Spiti districts and tribal areas of Pangi and Bharmour Subdivisions of Chamba districts with Project headquarter at Kullu (Shamshi), district Kullu and Regional office at Rampur, district Shimla.

World Bank Aided Integrated Development Project for Source Sustainability and Climate Resilient Rain-fed Agriculture

The project would be implemented in 900 Gram Panchayats in Shivalik and Mid Hills agro-climatic zones spread across various watershed in the State. The key objectives of this project include comprehensive treatment of around 2 lakh hectares non-arable and 20,000 hectares arable lands; and enhancement of water productivity/ efficiency of Milk production and livelihood improvement in the project area.

Environment Forestry and Wildlife

The scheme aims at protection, improvement of environment and wildlife, development of wildlife sanctuaries/national parks and improvement of wildlife habitat so as to provide protection to various species of birds and animals facing extinction, and to protect, develop and scientifically manage the wildlife and to improve its habitats.

Farm advisory service

1. Diagnostic team visits
2. Field demonstration
3. On-Farm trials
4. Organisation of Kisan Melas, Kisan divas, field days
5. Field visits
6. Village adoption
7. Veterinary clinical camps
8. Farm and home visits
9. Celebration of important days

Education and trainings

On campus trainings

1. Training programmes of short duration (one day to one month) on various aspects of agriculture and allied fields viz.,
 - a) Watershed management
 - b) Improved agricultural technology
 - c) Vegetable growing
 - d) Bee- keeping

- e) Mushroom cultivation
- f) Vermi- composting
- g) Dairy management
- h) Fish farming
- i) Fodder and Pasture management
- j) Integrated pest management
- k) Home science

These trainings are organized for the benefit of farmers, women group, mahilla mandals, unemployed youths, self help groups, entrepreneurs, officers of different government departments as well as to NGOs.

Off Campus training

- a) One day off campus training programmes are also organized under different projects in the project areas.
- b) Organization of trainings and workshops.
- c) Provide common platform for interaction among university scientists, officers of the agricultural department, other extension workers and progressive farmers. Rabi workshop and Kharif workshop are organized every year before the commencement of Rabi and Kharif seasons, respectively.
- d) In these workshops, new recommendations of the university for improving agricultural production as well as emerging problems and issues are discussed and packages of practices for cereal crops are finalized.

Farm Information and Communication

- a) ATIC
- b) Publications
- c) Museums
- d) Use of electronic media such as radio talks, radio pathshala or different aspects viz.,
 - 1) Beekeeping
 - 2) Pulse cultivation
 - 3) Agricultural engineering
 - Live phone-In programme from Doordarshan, Shimla
 - a) Use of print media
 - b) Fortnightly information on important activities in agriculture and animal husbandry published in local newspapers in Hindi & English.

Selection of the respondents-

Public sectors- It includes agriculture and allied department services such as ATMA, KVK, SAUs, Farms, ICT led extension such as community radio station, Kissan call centre etc, farms ACABC, Marketing

ATMA Pilot Projects-

1. Bilaspur
2. Hamirpur
3. Shimla
4. Kangra

KVKs (agritech.tnau.ac.in)-

1. Krishi Vigyan Kendra Chamba P.O.Saru Distt. Chamba
2. Krishi Vigyan Kendra Near Petrol Pump Rohru Distt.Shimla
3. Krishi Vigyan Kendra Kinnaur at Reckong Peo Distt. Kinnaur
4. Krishi Vigyan Kendra P.O. & Teasel Kandhaghat Distt. Solan
5. Krishi Vigyan Kendra Kangra Distt□ Kangra
6. Krishi Vigyan Kendra CSKHPKV Hamirpur at Bara Distt. Hamirpur
7. Krishi Vigyan Kendra Rampur Distt. Una
8. Krishi Vigyan Kendra Regional Research Station Dhaulakuan Distt. Sirmaur
9. Krishi Vigyan Kendra CSKHPKV Research Sub Station Birthin Distt. Bilaspur
10. Krishi Vigyan Kendra CSKHPKV Bajura Distt. Kullu
11. Krishi Vigyan Kendra Sundernagar Distt□Mandi
12. Krishi Vigyan Kendra CSKHPKV RRS Lahual & Spiti Distt. Kukumseri
13. Krishi Vigyan Kendra village Tabo, Lahual & Spiti (6/01/2017)

Community Radio Stations

1. Community radio stations, Hamara MCPICM 90.4 MHz in Solan
2. Community radio stations, Tashi Delek 90.4 FM in Kangra

SAUs-

1. Ch. Sarwan Kumar Krishi Vishwavidyalaya, Palampur
2. Dr. Y. S Parmar University of Horticulture & Forestry, Solan (Nauni)

ICT led Extension services-

1. Community Radio Station (Solan and Kangra)
2. mKishan
3. Kishan Call Centre (Shimla)
4. Farmers Portal
5. All India Radio Station

6. AGRISNET
7. AGMARKNET

Private sectors- Agriculture related companies includes

1. Jai mata dee nature fresh private limited
2. Kangra agro producer company limited
3. Himganic farmers producer company limited
4. Green him food processing private limited,
5. CBD Biomedica (India) private limited
6. Seraj agrocare private limited
7. Himagri vision producer company limited
8. Himmap herbals private limited
9. Bushahr farmers producer company etc

Public Private sector-

1. Farmers Training Centre, Dharamsala
2. Agriculture Training Centre, Shimla
3. HPMC
4. Indian Society of Agribusiness Professionals (ISAP)
5. Himachal Consultancy Organisation Ltd
6. PACs
7. Market complex

NGOs- Agriculture related NGOs in Himachal Pradesh-

1. Community Empowerment Organisation for development (Chamba)
2. High tech Education and Welfare Society (Chamba)
3. Mahila Vikas Manch (Chamba)
4. Him Aishvary Gramin Udyog Avam Laghu Bhagat Kalyan Sangh (Dharamsala)
5. Parvatiya Krishi Avam Gramin Vikas Sansthan (Dharamsala)
6. Shiva Yubak Mandal (Hamirpur)
7. People awareness for rural action society Para (Mandi)
8. Mahila Kalyan Sansthan (Kangra)
9. Prayukti Youth Organisation (Kangra)
10. Society for Advance Rural Technology and Health Awareness (Kangra)
11. Sadprayas (Kullu)
12. Sure Society for Upliftment of Rural Economy (Kullu)
13. Layul Tribal Welfare Association (Manali)
14. Matri Bhumi Social Welfare (Mandi)
15. Parayavaran Avam Gramin Vikas Sansthan (Mandi)

16. Prayaywaran Sabha (Mandi)
17. Rural Action and Research Centre (Mandi)
18. Society for Technology and Development (Mandi)
19. Sidhi (Sirmaur)
20. Maa Saraswati Society (Palampur)
21. Action Research and Training (Sirmaur)
22. Himalayan Research Group (Shimla)
23. Jan Abhiyan Sanstha (Shimla)
24. Dignity (Solan)

Animal husbandry related NGOs in Himachal Pradesh-

1. Jan Seva Samiti Lylh
2. Samaj Kalyan Awam Vikas Mandal (Mandi)
3. Hind Seva Sangathan (Shimla)
4. Sanjeevani (Mandi)
5. Shanti Shiksha and Social Welfare Society (Mandi)
6. Sarvajyoti Social Welfare Educational and Rural Development Society (Mandi)
7. Wonderland Ecotourism Foundation (Kullu)
8. Samajik Suraksha Evam Vikas Samiti (Kullu)
9. Society for Environmental and Rural Awakening (Kangra)
10. Aaa Yatn (Kullu)
11. Awareness of Global Environmental Friendship Society (Mandi)
12. Aqsa Educational and Welfare Society (Kullu)
13. Manav Seva Chamba
14. Nar Seva Samiti (Chamba)
15. Nav Chetna (Chamba)
16. Shiv Bhoomi Society for Human and Development for People and Nature (Chamba)
17. Suraksha Welfare Foundation (Solan)
18. Association for Social and Hills Advancement (Kangra)
19. Computer Literacy Mission Society (Dharamshala)
20. Anita Salaria Memorial Trust (Shimla)
21. All India Social Awareness Society HP (Himирpur)
22. Jai Baba Kamlaһiya Aradhana Society (Hamirpur)
23. Nav Yuvak Mandal (Hamirpur)
24. RDS Educational Society (Mandi)
25. Vision (Mandi)
26. Maharana Kalyan Jan Kalyan Sansthan
27. Friends club (Kangra)
28. Maa Shakti Swayam Sewi Sangathan (Kullu)
29. Gulmohar Society for Educaton Research and Development (Mandi)
30. Himalayan Jan Kalyan and Sankriti Manch (Sirmaur)

31. Brag Kishan Vikas Jan Kalyan Samiti (Shimla)

Environment and Forest related NGOs in Himachal Pradesh

1. Kangra Mahilla Sabha (Kangra)
2. Devdhar Educational Society (Mandi)
3. Himalayan Rural Development Society (Mandi)
4. Incredible Himachal (Mandi)
5. Serve Himalaya Society (Shimla)
6. Himalayan Awakening Society (Sirmaur)
7. Satluj Power (Shimla)
8. Jan Jagran Gram Kalyan Samiti (Mandi)

Micro Finance related NGOs in Himachal Pradesh

1. Women and child Development Society Masrood (Chamba)

Vocational training related NGOs in Himachal Pradesh-

1. Sai Charitable and Social Welfare Society
2. Institute for Social Work (Palampur)
3. Una Grahak Suraksha Samiti (Una)

Rural Development, Poverty alleviation and Women Development related NGOs in Himachal Pradesh-

1. Nav Nirman Kalyan Samiti (Kangra)
2. HP Mahila Kalyan Mandal (Kullu)
3. Jagriti (Kullu)
4. Fingate Foundation (Manali)
5. Society for Human Awareness Knowledge and Tribal Improvement (Sirmaur)
6. Bvn Society (Sirmaur)
7. Educational Society for Informaton Technology (Shimla)

Disaster Management related NGOs in Himachal Pradesh-

1. Nihal Public Welfare and Environment Conservation Volunteer Society (Hamirpur)
2. Mountain Forum Himalaya (Shimla)

Farmers Producer's Organisation (FPO)

1. Dharampur Vegetable Producer Company Limited

2. Mashobra Vegetable Producer Company Limited
3. Saindhar Producer Company Limited
4. Solan Sirmour Kisaan Samridhi Producer Company Limited
5. Banasar Kissan Samridhi Producer Company Limited (Solan)
6. Kangta Agro Producer Company Limited (Sirmaur)

Working Group on Mission for Sustaining the Himalayan Eco-System

1. HFRI (Himalayan Forest Research Institute), Shimla
2. Department of forest
3. NBPGR (National Bureau of Plant Genetic Resources), Shimla
4. GBPIHED (G. B Pant Institute of Himalayan Environment & Development), Kullu
5. IHBT(Institute of Himalayan Bio resources Technology), Palampur
6. SASE(Centre for Snow and Avlanche Study Establishment), Chnadigarh
7. PG College Dharamsala
8. Department of Bio Sciences, HPU (Himachal Pradesh University)Shimla
9. ZSI(Zoological Survey of India), Solan
10. IIHS(Institute of Integrated Himalayan Studies), HPU, Shimla

Working Group on Mission for Sustainable Agriculture and Horticulture-

1. CSK HPKV(Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidhalaya), Palampur
2. UHF (Dr. Y S Parmar University of Horticulture and Forestry), Nauni
3. Regional Research Station, Masobra
4. CPRI (Central Potato research Institute), Shimla
5. IARI(Indian Agricultural Research Institute), Regional Station

Different partners of Himachal Pradesh under state centre on climate change

Research Institute

1. Institute of Himalayan Bioresource Technology, Palampur, Himachal Pradesh
2. Himalayan Forest Research Institute, Shimla, Himachal Pradesh
3. G. B Pant Institute of Himalayan Environment & Development, Kullu
4. National Bureau of Plant Genetic Resources, Shimla
5. Central Potato research Institute, Shimla
6. Indian Institute of Himalayan Studies, Himachal Pradesh university, Shimla
7. Institute of Biotechnology and Environmental Sciences, Neri, Hamirpur
8. The Energy and Resources Institute, Teri (new Delhi)

Universities-

1. CSK HPKV(Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidhalaya), Palampur
2. YSP UHF (Dr. Y S Parmar University of Horticulture and Forestry), Nauni
3. Government College, Dharamshala, Kangra
4. Himachal Pradesh University, Shimla
5. Indian Institute of Himalayan Studies, Shimla

Government Organisations-

1. Central Water Commission, Shimla
2. Zoological Survey of India, Solan
3. Snow and Avlanche Study Establishment, DRDO, Chandigarh
4. Forest Department, Himachal Pradesh
5. Department of Environment, Science and Technology, Shimla
6. Himachal Pradesh State Pollution Control Board, Shimla
7. Space Application Centre, Ahmedabad

NGOs-

Research Design

| Shivalik Hill Zone | Mid Hill Zone | High Hill Zone | Cold Dry Zone |
|---------------------------------|------------------------|----------------|-------------------------------|
| Kangra, Hamirpur, Una, Bilaspur | Solan , Mandi, Sirmaur | Kullu, Shimla | Chamba, Lahaul-spiti, Kinnaur |

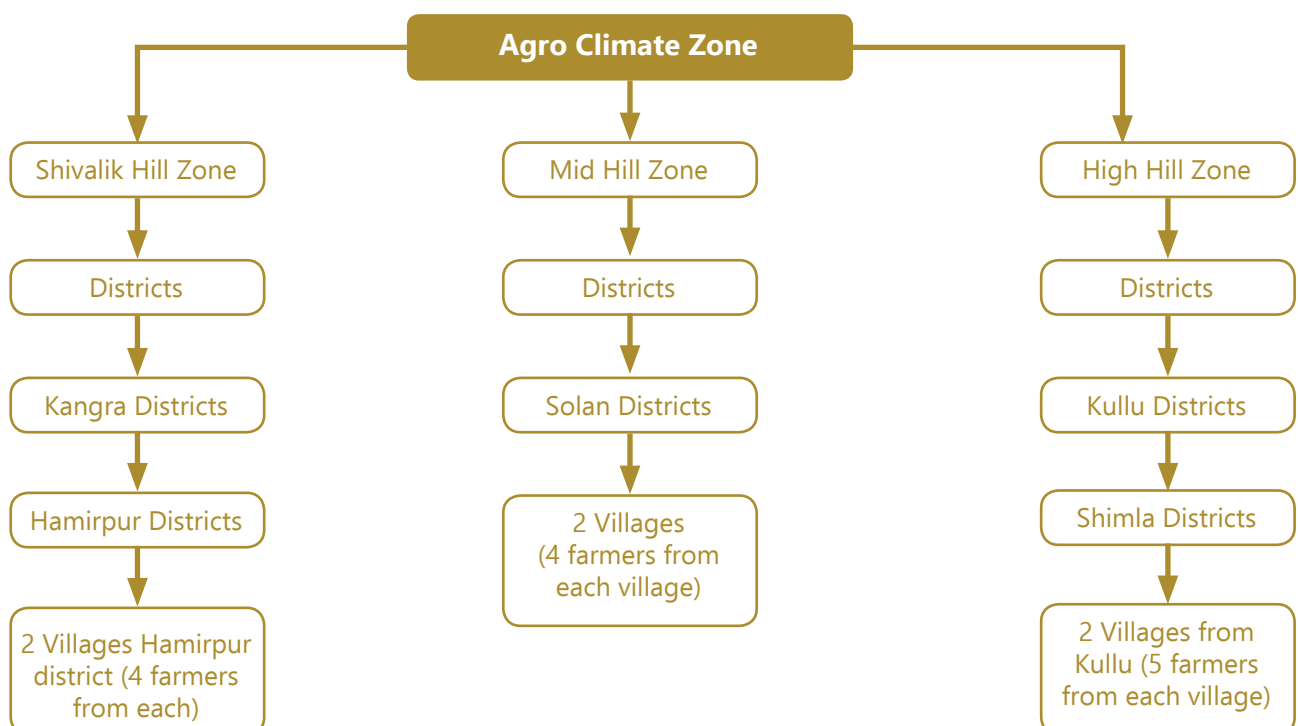


Fig 8: List of selected respondents during data collection

ATMA Pilot Projects-

1. Shimla
2. Hamirpur
3. Kangra

KVKs (agritech.tnau.ac.in)-

1. Krishi Vigyan Kendra Near Petrol Pump Rohru Dist. Shimla
2. Krishi Vigyan Kendra Kangra Dist. Kangra
3. Krishi Vigyan Kendra, Kullu
4. Krishi Vigyan Kendra, Hamirpur
5. Keishi Vigyan Kendra, Solan

Community Radio Stations

1. Community radio stations, Hamara MCPICM 90.4 MHz in Solan
2. Community radio stations, Tashi Delek 90.4 FM in Kangra

SAUs-

1. Ch. Sarwan Kumar Krishi Vishwavidyalaya, Palampur
2. Dr. Y. S Parmar University of Horticulture & Forestry, Solan (Nauni)

ICT led Extension services-

1. Community Radio Station (Solan and Kangra)
2. mKishan
3. Kishan Call Centre (Shimla)
4. Farmers Portal

NGOs-

1. Himalayan Research Group (NGO)
2. M R Morarka-GDC Rural Research Foundation
3. Yuvak Mandal, kullu
4. Kisan Sabha (NGO)
5. Himalayan Mahilla Avm Kalyan Sanstha, Hamirpur

Other respondents-

1. HFRI (Himalayan Forest Research Institute), Shimla
2. CPRI (Central Potato research Institute), Shimla

3. IARI (Indian Agricultural Research Institute), Regional Station

Universities-

1. CSK HPKV(Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidhalaya), Palampur
2. YSP UHF (Dr. Y S Parmar University of Horticulture and Forestry), Nauni

Area of study

For the current study, data was collected by using ex post facto method. From the selected zone, districts were selected purposively. Districts having more area of production and productivity in the field of agriculture, horticulture, animal husbandry, etc., and where the Directorate of Extension Education, Palampur conducts a large number of trainings for farmers, livestock keepers, farm ladies, rural youth etc. in respective districts were chosen. The selected areas for the present study are vulnerable to climate change and have more participation of extension services (Annual administrative report, 2018).

By taking the help of KVKs, a list of farmers who avail services in selected districts was taken, and From the 3 districts, 10 farmers, 5 farmers each from 4 village (2 villages from each district) of 2 districts (Hamirpur and Kullu district), and 4 farmers each from 2 village each of Solan district making a total of 6 villages were selected by stratified random sampling for making the sample of present study. Also, all the sectors which provide services to the farmers in the field of Agriculture, Horticulture, Fisheries, Animal Husbandry, Forestry, etc., such as public sector, private sectors, NGOs, Public-Private sectors were selected purposely to prepare the list of respondents.

Data Collection Tools and Techniques

First phase - Data or information on the different roles of extension services in adaptation to climate change and impact as well as adaptation practices to climate change used by farmers was collected after reviewing the annual reports, research papers and online published reports, books, magazines, etc.

Second phase - Extension agents from different sectors were interviewed in groups or/and individually in the selected study areas with the help of semi-structured interview guide. For NICRA project, scientists of KVKs, where the project is going on, were interviewed to collect the information. Third Phase- Farmers were interviewed in groups/ individually, using semi-structured schedule to find out the impact of climate change, and the adaptation practices used by farmers to cope up with the change of climates. Focus Group Discussion (FGD) and Observation Method were also used to support the collected data.

For the present study, both primary and secondary data were used. Primary data was collected and calculated quantitatively and qualitatively. In quantitative data, information was collected through

measuring things such as impact and adaptation, whereas, in qualitative, data was collected through the participant's observation and interviews.

Secondary data were collected after reviewing the annual reports, research papers, and online published reports, books, magazines, etc. It helps to explore the impact of climate change, various climate resilient practices, and role of extension services in the selected districts of Himachal Pradesh to achieve the objectives of the study.

The primary data were collected by conducting telephonic conversations and face-to-face interviews by the respondents. For the purpose of the present study, a semi-structured interview schedule was prepared and focus group discussions and observation methods were done to collect the information.

Results and Discussion

Table 11: Horticulture crops in Himachal Pradesh (fruits, vegetables, flower crops etc)

| S. No. | Crop | Name of variety/ hybrid(s) |
|--------|-------------|---|
| 1. | Pear | Bartlette, Max Red Bartlette, Bogugosha |
| 2. | Plum | Frontier, Mariposa, Santarosa |
| 3. | Pomegranate | Khandhari Kabuli |
| 4. | Tomato | Roma,Rupali,Nutan |
| 5. | Peas | Azad P-1, ArKel |
| 6. | Cauliflower | PSB K-1,Pusa Snoball |
| 7. | Cabbage | Goldan Acre |
| 8. | Garlic | GHC-1,Agrifarmed Parvati |

In Himachal Pradesh, particularly in Kullu district, the impact of climate change is huge as rainfall is decreasing day by day and temperature is increasing. There is a shifting of crop from one place to another takes place. Farmers mainly grow cash crops which include pomegranate, cauliflower, peas, garlic, etc., which gives a higher return to the farmers. In Kullu district, previously apple was the main crop which was grown but due to the change in climate, apple orchards are becoming less.



After the introduction of NICRA Project in the district, farmers are taking advantage of different cash crops which help in increasing their economic status level. Many extension agents are responsible for the information given to the farmers in a big way but there is no linkage between different sectors resulting in less output.

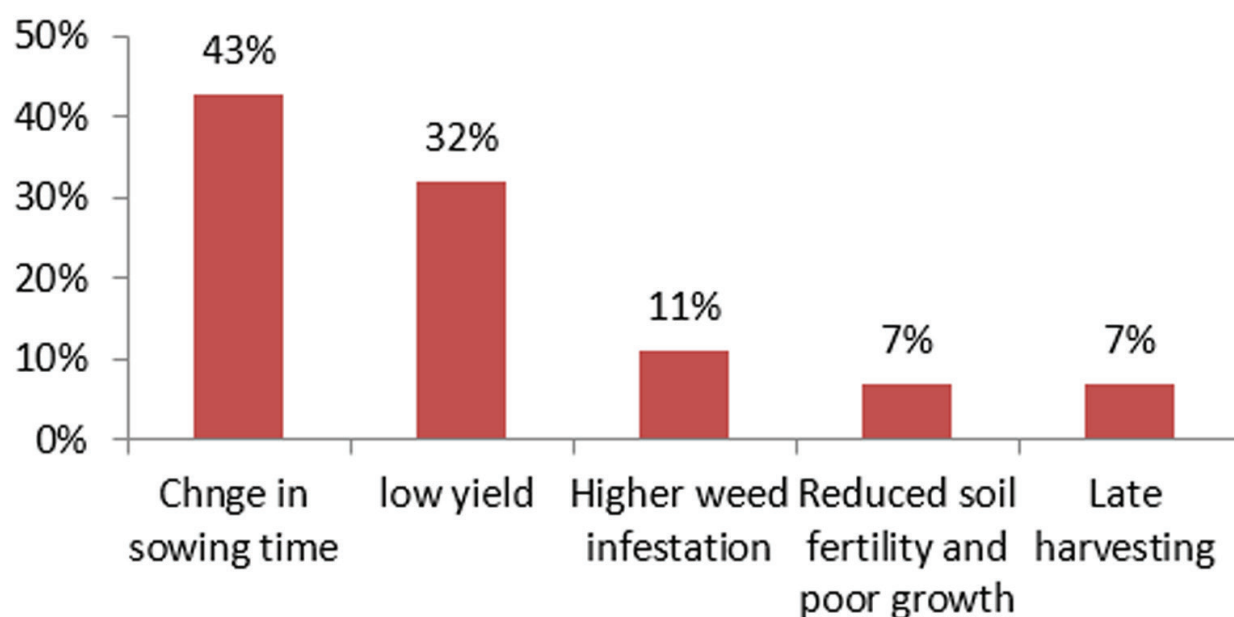
Table 12: Livestock information and disease found

| S. No. | Livestock type | Major livestock diseases |
|--------|-----------------|--|
| 1. | Small Ruminants | FMD, Parasitic Infestation. |
| 2. | Large ruminants | Mastitis, Babesiosis, Parasitic Infestation, FMD, Repeat Breeding, Anestrus. |
| 3. | Poultry | Parasitic Infestation |

Due to the climate change, many diseases are profound in different areas of Himachal Pradesh which results in a change in the livestock activities.



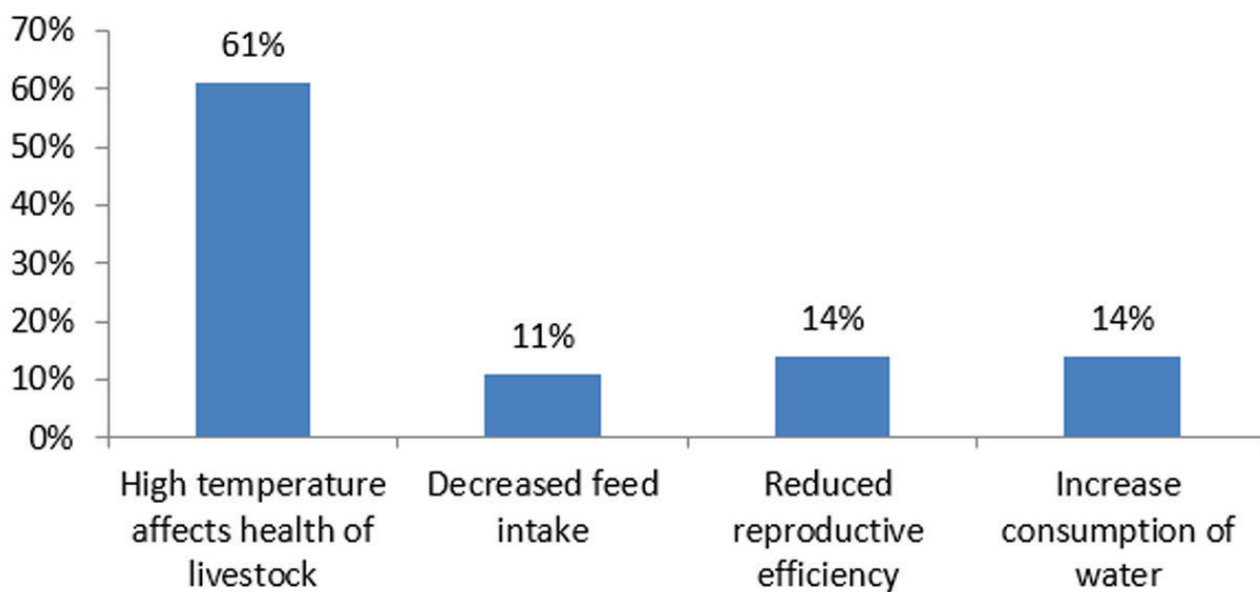
Table 3: Impact of climate change on crop production (n=28)



Climate change causes greater impact on crop production. Maximum (43.00%) of the respondents observed the greater change in sowing time due to climate change while 32.00 per cent of the respondents experienced low yield. Also, respondents (11.00%) face the problem of higher weed infestation. Equal number of the respondents felt the negative impact of climate change like reduced soil fertility & poor growth, and late harvesting i.e., 7.00 per cent.



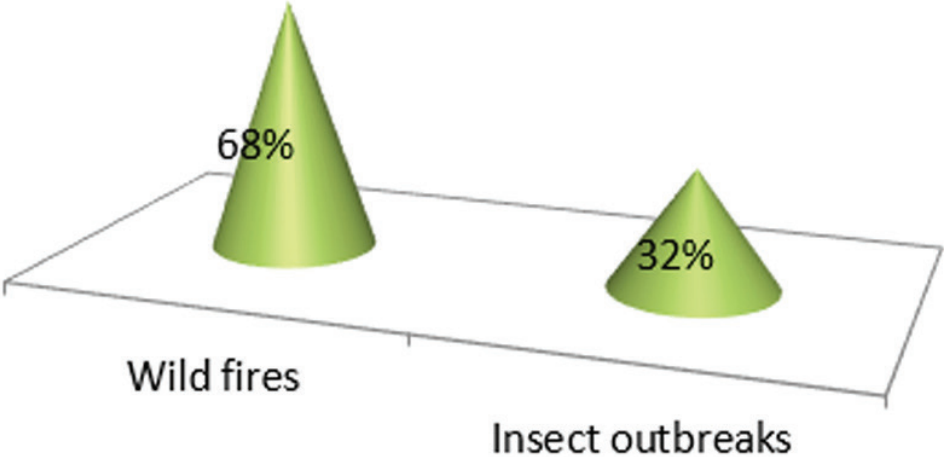
Table 4: Impact of climate change on animal husbandry (n=28)



In Table 4 it is clearly shown that 61.00 per cent of the respondents are facing the problems of higher temperature which affects the health of their livestock. Due to climate change, animals are having reduced reproductive efficiency as well as increased consumption of water (14.00%), whereas, 11.00 per cent are facing decrease feed intake.

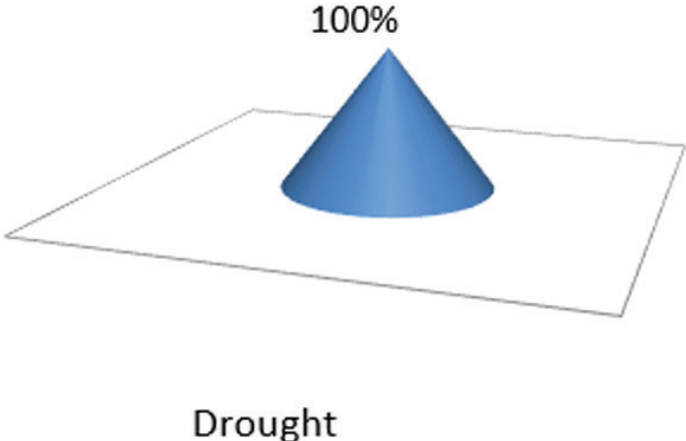


Table 5: Impact of climate change on forestry (n=28)



From the study, it is observed that the highest number (68.00%) of the respondents felt the problems of wild fires, whereas, 32.00 per cent experienced insect outbreaks.

Table 6: Impact of climate change on fisheries (n=28)



In Himachal Pradesh, fish production is less so there is no such impact except drying up of ponds which leads to death of the fish due to the high temperature in those areas.

Table 7: Impact of climate change on human health (n=28)

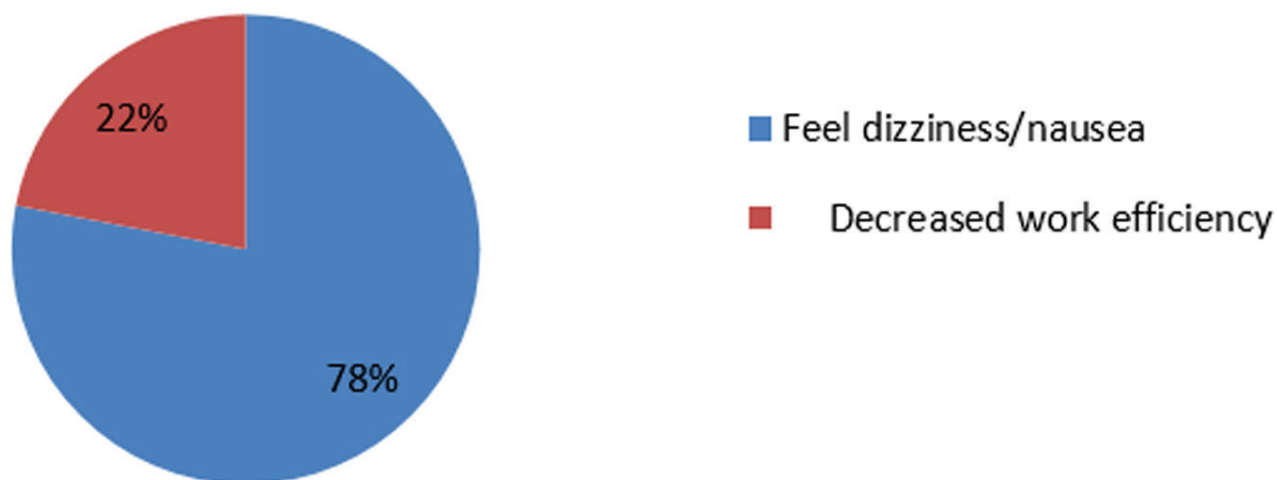


Table 7 elucidated the huge impact of climate change on human health. Maximum (78.00%) number of the respondents felt dizziness/nausea, while 22.00 per cent of the respondents felt a decrease in work efficiency due to the increase in temperature.

Table 8: Impact of climate change on food security (n=28)

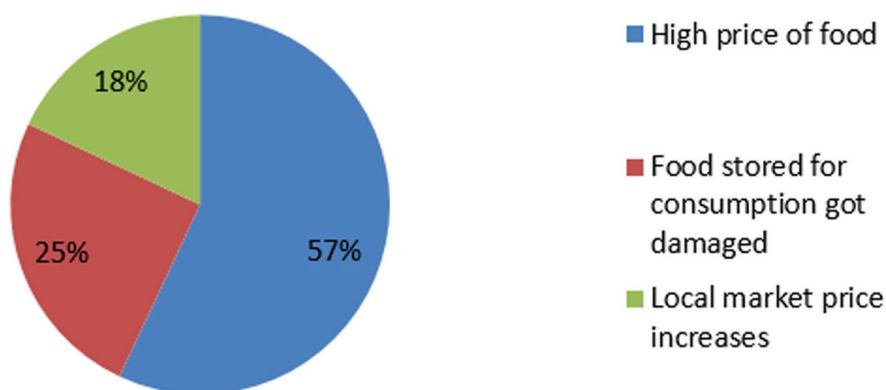
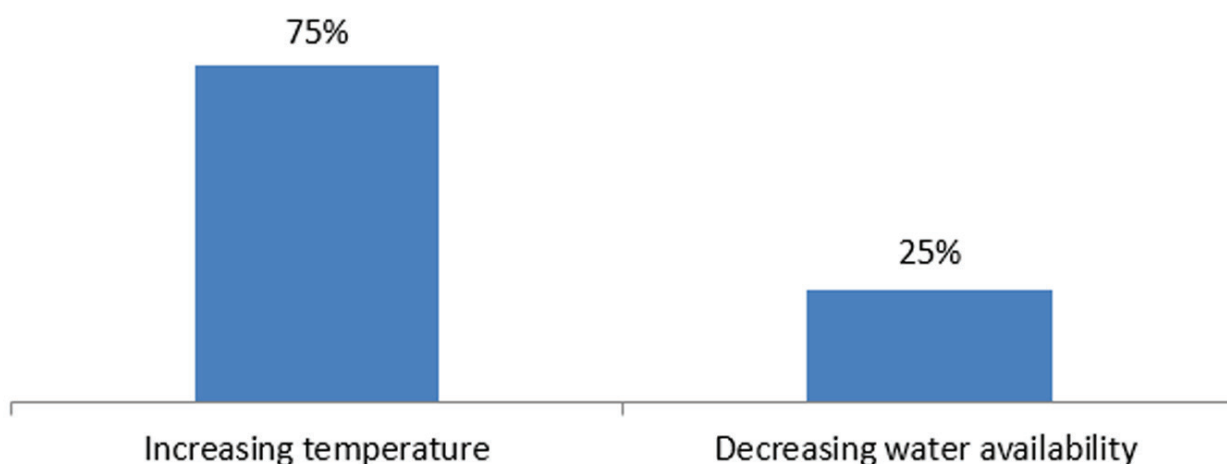


Table 8 reveals how climate change has a big impact on food security. From the total selected respondents, 57.00 per cent felt the increase of food prices, whereas, 25.00 per cent of the respondents felt food stored for consumption got damaged due to climate change resulting in increase in temperature and humidity. Among the 28 number of the respondents (18.00%), 5 respondents observed that the local market price increases due to climate change.

Table 9: Impact of climate change on energy and water resources (n=28)



There is a great impact of climate change on energy and water resources. More than seventy per cent (75.00%) of the respondents felt an increase in temperature which affects all the day-to-day activities of the people, and 25.00 per cent of the respondents felt decrease in water availability.

Table 13: Adaptation to climate change among farmers in selected districts of Himachal Pradesh (n=28)

| S. No. | Discipline | Adaptation practices |
|--------|---------------------------------|---|
| 1. | Crop Production | Changed from long duration varieties to short duration varieties, shifting from one crop to another, changing the spacing between the rows/plant. |
| 2. | Animal husbandry | Cross breeding, provision of shade, home and supplement feeding, and health care |
| 3. | Soil and water conservation | Use of drought tolerant varieties, farm pond, ridges and furrow, mulching, drip irrigation, sprinkler irrigation |
| 4. | Forestry | Enhance water nurseries and avoiding excessive diversion of forest land for long term |
| 5. | Fisheries | Improve water use efficiency, selective breeding |
| 6. | Subsidiary activities initiated | Dairy +goat rearing, Dairy, poultry |

From the study, it is concluded that farmers are adopting many practices in different fields. In crop production, farmers are adopting crop diversification in which they are changing their crop from long duration varieties to short duration ones, and changing the spacing between the rows/plant. In animal husbandry, respondents are practicing cross breeding. They are also giving provisions of shade, home and supplement feeding, and health care to improve the condition of the animals and particularly to improve the yield of milk. In case of soil and water conservation, they are practicing

drought tolerant varieties, farm pond, ridges and furrow, mulching, drip irrigation, and sprinkler irrigation. In forestry, farmers are enhancing water nurseries, and avoiding excessive diversion of forest land for the long term to save the forest. Farmers are using selective breeding and improving water use efficiency to improve the fishery conditions. They are adapting Dairy +goat rearing, Dairy and poultry as subsidiary activities.

Table 14: Role of extension services in adapting to climate change in Himachal Pradesh

| S. No. | Extension services | Sectors | Technology disseminated/ method used | Services |
|--------|--------------------------------|---------|--|---|
| 1. | Himalayan Research Group (NGO) | Private | <p>Industrial unit - mushroom compost preparation unit HRG established mushroom compost preparation unit. Around 250-275 MT spawned mushroom compost with pasteurized, casing soil is provided annually to the growers to produce around 50 MT button mushroom.</p> <p>Essential oil extraction unit- HRG has set up 100 kg pilot scale aromatic plant extraction unit to provide processing facilities to the growers of aromatic plants at village Dhagiara, Distt. Mandi H.P. Growing of Rose and Lavender is popularised among the farmers through distribution of planting material and processing facilities. Lavender oil and Rose water produced in District Mandi is of international grade. Products of HRG- Spawned button mushroom compost with pasturised casing oil, Cultivated Chirata, Seed of Chirata, vermiculture, models and design of low cost polyhouses, models and designs of solar passive retrofitting</p> | They have covered six districts of Himachal Pradesh namely- Shimla, Mandi, Kullu, Kinnaur, Sirmaur and Chamba. Outside Himachal, they have covered four states namely,- Maharashtra, Arunachal Pradesh, Uttarakhand, Jammu & Kashmir to demonstrate the technology which helps people directly or indirectly adapt the technology useful to control the climate change. These technologies are cost effective and market oriented results in overall development of the rural people. |

| | | | | |
|----|---|---------|--|---|
| 2. | M R Morarka-GDC Rural Research Foundation | Private | Consulting areas- Organic Farming, Organic Farm Produce, Value addition of crops, Farm tourism, Organic bakery business, Value chain management in agriculture, etc. | Pioneered Organic Agriculture Development, Expert in Social Entrepreneurship Development, Pioneerred Vermiculture technology, etc. |
| 3. | Yuvak Mandal, kullu | Private | Providing necessary training to the male members of the Kullu district for upliftment of the people in that area. Giving trainings of different local technology which are eco-friendly in nature and contribute to the environment | Mandal giving award to the farmers who contribute to the society by making the environment clean. Providing updated information to the farmers with the help of facebook, whatsapp etc. |
| 4. | Kisan Sabha (NGO) | Private | Himachal Kisan Sabha is peasants' organization which works for farmers' rights. | Make better provision for irrigation; provide information with the help of Facebook, etc, conduct different rallies by farmers related to land issues, forest land cultivators, wild animal menace as well as remunerative prices for the farmers' produce. |
| 5. | Himalayan Mahilla Avm Kalyan Sanstha, Hamirpur | Private | Organising seminars and trainings for the women to improve their economic status in the society, conducting different seminars, workshops to spread awareness among the women regarding environment under Swachha Bharat Mission. | |

| | | | | |
|----|---|--------|---|---|
| 6. | Chaudhary Sarwan Kumar Himachal Pradesh Krishi Viswavidyalaya, Palampur | Public | Crop diversification, water harvesting management, natural farming, proper sheds for animals, farm ponds, storage tanks, etc., required to combat with climate change. | University works related to agriculture and allied activities for disseminating technologies for combating climate change and taking corrective actions and recover the situations. Giving proper training to the farmers and extension agents as well as collaborate with different institutes to recover the situation. |
| 7. | Dr. Y S Parmar University of Horticulture & Forestry | Public | Crop diversification, Improved metal cookware for high altitude areas, water harvesting technique, water conservation techniques, mulching, solar dryer, natural farming, irrigation system, pre weather forecasting agro advisory services, lab to farm technique, bee hive techniques, student to farmer linkages, prediction model, modelvillage, Fasal project, Hitech horticulture etc. (Department of environment and forestry) | More focused on fruits and vegetable as well as forest. Crop diversification is the main agenda and foremost technique for combating climate change problem, started pomegranates cultivation instead of apple cultivation, giving training to the farmers and some NGOs to disseminate the technology to the rural people in a better way, work in NICRA Project with the KVK Kinnaur and Chamba, giving updated information with the help of Radio, TV, newspaper, local TV channels and publications. Under hi tech technology they made poly houses and |

| | | | | |
|-----|---|--------|---|---|
| 8. | State centre on climate change | Public | Main objective is to deploy the appropriate technologies for both adaptation and mitigation of green house gases. Also, work to protect, and preserve the forest cover and the biodiversity for effective carbon sinks. | farmers are following in a big way to combat climate change. Create and generate awareness amongst various stakeholders for taking appropriate measures in combating the impacts of climate change, evolve various modules for mitigation of natural disaster threat in Himachal Pradesh, strengthen the capacity building in disaster management etc. |
| 9. | HFRI (Himalayan Forestry Research Institute | | Generate, preserve, disseminate advance knowledge, technologies and solutions related to forests and environment through research, education, and extension. They are having different divisions, conducting activities related to management practices including insect-pests management in temperate forests and in alpine areas. Institute also enhances the popularization of forestry and other related extension activities in the State of Himachal Pradesh. | Research institute works under the Indian Council of Forestry Research and Education of the Ministry of Environment and Forests, Govt. of India |
| 10. | G B Pant Institute of Himalayan environment & Sustainable Development | Public | Working on traditional soil conservation techniques of the Kullu and Lahaul valleys in the North Western Himalayas; maintenance and monitoring of experimental herbal garden and medicinal plant nurseries and ex situ cultivation trails etc. | Institute is working for sustainable development of rural systems, land and water resource management, conservation of biological diversity and ecological economics and environmental impact analysis. |

| | | | | |
|-----|-----------|--------|---|--|
| 11. | HIMCOASTE | Public | Himachal Pradesh Council for Science, Technology & Environment is disseminating the technologies such as green house propagation (M. S lean to wall green house, Gable type green house, tunnel type pipe frame green houses, bamboo frame tunnel type greenhouse, forest water biomass, and rain water harvesting. | Green house propagation helps to improve the plant growth, use of water is optimized due to reduced evapo-transpiration, crop is protected from rain, hail storm, wind and frost etc, Rain water harvesting is cost effective tool for meeting out the water demand during the lean periods. |
| 12. | ATMA | Public | Work with universities for dissemination of technologies to the community or to the stakeholders in an efficient manner. | Agricultural Technology Management Agency work in district level to transfer the technologies to the beneficiaries |
| 13. | ATIC | Public | Updated information through phone calls, sending personal letter to solve the problems in an effective way. Conducts many trainings to upgrade the status of the beneficiaries | Agricultural Technology Information centre with the help of meteorological department send the updated and pre weather advisory services to the farmers to take corrective action related to climate change, providing free call services to the farmers for interaction with extension agents directly. |

| | | | | |
|-----|-------------------------|--------|--|---|
| 14. | Community radio station | Public | Weather information, insect pest control techniques, discussion on different technologies and way to use these technologies in a proper manner and to give the information about the advantages with the help of different experts in the relevant fields. | Cover most of the areas to solve the problems of the rural people in a better way |
|-----|-------------------------|--------|--|---|

Table 15: Role of extension services in adapting to climate change in Himachal Pradesh

| | |
|---|---|
| Project area: | Hamirpur |
| Name of villages: | Mann, Tareti, Ghumarta, Kuthera, Janglu1, Janglu2, Ranghar, Marhoon No. and name of villages covered: 2& Mann and Tareti |
| Natural Resource Management | |
| 1. In-situ moisture conservation measures | Ridge and furrow method in bitter gourd (Palee) Biomass mulching in Colocasia (Local) |
| 2. Vermi compost through vermibed | Vermiculture |
| Crop Production | |
| 1. Drought tolerant varieties | Wheat HPW 360 Wheat HPW 368 |
| 2. Crop diversification | Bitter gourd Chaman/Palee Bottle gourd round (Marvi) Bottle gourd long (Sharda) Cucumber (Malav) Sponge gourd |
| 3. Insect pest control | Pheromone traps for fruitfly in bitter gourd |
| Livestock and fisheries | |
| 1. Introduction of improved breeds | Breed upgradation of goats (52) |
| 2. Improved feeding like location specific mineral mixtures | Mineral mixture feeding in cross bred animals (33) Mineral mixture feeding in buffaloes (18) UMB feeding in cross bred animals (36) Azolla feeding to cross breed animals (10) |

Institutional

| Intervention | Name of crops /varieties Commodity groups / Implements | Technology used in seed / fodder bank & function of groups |
|--|---|---|
| Custom hiring centre | Power Tiller | Field preparation for sowing of cauli flower |
| Climate literacy through a village level weather station | Cereals, oilseed and vegetable crops | Recording of observations on weather parameters at village to study their effect on crops |

Capacity building taken up (HRD)

| Thematic area | Title of training | No. of Courses |
|--------------------------------------|---|-----------------------|
| Crop Management | Integrated Pest Management | 4 |
| | Stored grain and IPM | 1 |
| | Biological insect pest control | 2 |
| | Pheromone traps for fruit fly control | 1 |
| | Importance of seed treatment | 1 |
| | Integrated farming | 1 |
| Enterprises for the self employment | Beekeeping | 1 |
| | Post harvest value addition | |
| Fodder and feed management | Azolla cultivation | 1 |
| Forest tree/ agroforestry plantation | Parthenium and Bhang eradication | 2 |
| Irrigation management | Role of Mulching in water management | 1 |
| Live stock management | Fodder and feed management in animals | 1 |
| | Animal health management | 1 |
| Management of horticultural crops | Scientific cultivation of vegetable crops | 3 |
| | Nursery raising of vegetables | 2 |

Extension activities

| Activity | Details about the activity |
|---------------------------|--|
| Strengthening kisan clubs | Motivation and awareness on marketing |
| Field days | Field day on traps |
| Method demonstrations | Fruit fly traps, Seed treatment, Biomass mulching, ridge and furrow method, Azolla, post harvest value addition, Vegetable Nursery Raising |
| Awareness | Parthenium and Bhang eradication |

Source: NICRA Annual report 2018

Table 16: Role of NICRA Project in Kullu districts of Himachal Pradesh

| | |
|--------------------------|---|
| Project area: | Kullu |
| Name of villages: | Choyal-Gadori, Seriber and Teguber No. and name of villages covered: 2 & Choyal-Gadori and Teguber |

Natural Resource Management

| S.No. | Intervention | Technology demonstrated |
|--------------|---|---|
| 1. | Water management measures and water saving measures | Community tank. Water Storage tanks (Constructed under other schemes like MNREGA, Water shed) Micro irrigation (drip/ sprinkler etc) |
| 2. | In-situ conservation measures | Mulching |
| 3. | Soil health improvement | Soil health card issued Vermicomposting |

Crop production

| | | |
|----|--|---|
| 1. | Crop diversification (foremost technology adapted) | To give alternate fruit crop to failure of apple in the village / rain-fed horticulture, introduction of Pomegranate takes place. It requires hot and dry weather and less water. The Cultivar Kandhari Kabuli is a recommended technology for commercial cultivation in Himachal Pradesh. Diversification in plum cultivar Diversification through high yielding varieties of tomato (Tomato varieties Heemshona & RK -123) |
|----|--|---|

| | | |
|----|---------------------------------------|---|
| 2. | Improved varieties of crops | High yielding variety resistant to YVMV in okra. High yielding new variety of French bean Advancement of sowing of spinach by two months to fetch high market prices. High yielding powdery mildew resistant varieties High yielding tomato varieties having high fruit firmness for distant market |
| 3. | Drought escaping / tolerant varieties | a) Drought tolerant and yellow rust resistant wheat varieties b) Drought tolerant high yielding Barley varieties c) Cultivation of early maturing maize composite varieties,; mature in 90-95 days,; medium height and resistant to lodging d) Deep Rooted /leguminous crop/Drought tolerant high yielding blackgram varieties e) Deep Rooted /leguminous crop /Drought tolerant high yielding varieties of soybean |
| 3. | Intercropping systems | Intercropping of Maize+ soybean (one row of soybean between two rows of maize) |

Livestock

| | | |
|----|--|---|
| 1. | Improved annual fodder crops demonstrated (oats) | African tall Maize+Cow pea(African tall+C475) Barseem Variety(Mascawe) |
| 2 | Perennial fodder crops introduced (Fodder trees) | Root slips of Napier bajra and Setaria |
| 3 | Silage units demonstrated | |
| 4 | Mineral mixture demonstrated | |
| 5 | Backyard poultry birds introduced | |
| 6 | Concentrated feed for goats | |
| 7 | Urea molasses Mineral Blocks | |

Livestock

| | | |
|---|----------------------------|--|
| 1 | Training program organized | |
|---|----------------------------|--|

Extension activities

| | | |
|---|--------------------------|--------------------------------------|
| 1 | Field days on rabi crops | Group discussion Diagnostic visit |
|---|--------------------------|--------------------------------------|

Method demonstration

Awareness

Agro advisory services

Field days on use of vermicomposting

Source: consolidated report-2011-18



Climate resilient Horticulture:-Pomegranate as an alternative cash crop to apple in foothill areas of District Kullu

Description of Innovation

Chhering Dorje (35yrs old) is living in village Gadori, P.O Shamshi, Block Kullu. His landholding includes both rainfed (1.4 ha) and irrigated (5.0 ha). He has five cows, and has 20 years of farming experience. The village Gadauri is situated in the foot hills of Kullu block of the district. Apple was the main cash crop of the village till early 90's but due to impact of climate change experienced during last three decades, the apple cultivation has shifted to higher hills. He was having an apple orchard in 3.5 ha area till 1995. Due to non-fulfillment of chilling hours owing to climate change in the foot hills, the apple production was drastically reduced. Keeping in view the climate change especially rise in winter temperature, Sh. Chhering Dorje planted few plants of pomegranate during early 90's. After 5 years, he observed good crop and decided to replace whole apple orchard with pomegranate. He planted pomegranate in an area of 3 ha (1800 plants) during 1997. Now, his gross income is 25-30 lakhs per annum and the net income to the tune of 20-25 lakhs per year from pomegranate farming which is much more than the apple farming.



Specifications of the practice

Planting density was increased by reducing the recommended spacing. He planted pomegranate cultivar Kandhari Kabuli at a spacing of 4 x 4 meter instead of the recommended practice of 5 x 5 meter therefore, accommodating 225 plants more than the recommended. He got award from ATMA Samooh Award for doing best agricultural practices.

Practical Utility of Innovation

The innovation has significant practical utility for the farmers in the foothills of the district where apple production has drastically reduced and the area has become marginal for apple production. The productivity of pomegranate is about 20-25 t/ha and farmers are getting good average prices (i.e. Rs 40-50 /Kg) irrespective of different grades. One can earn up to 6 to 8 lakhs /ha per year. Income from the Pomegranate farming ranges from Rs.6.0 lakhs /ha to Rs.8.0 lakhs/ha with BC ratio ranging between 4.0 - 5.0.

Utility of the innovation from the climate change perspective

Apples in the Himalayan foothills are seeing the worst effects of climate change. Orchards are shifting to higher altitude with shortening of winter season. There is a perception that the temperature distribution has undergone a significant shift in addition to an overall increase in temperatures. The periodicity of temperature is believed to be influenced by the timing of snowfall. Late snowfall, for example, was implicated as a causal factor leading to cooler temperatures in March and April. Further, definite reduction in snowfall over time in the higher ridges of Kullu district was thought to oscillate in 2 important ways: reduction in the intensity of snowfall, and changes in the timing of snowfall. This has resulted in the shift of apple cultivation to the higher altitude as it has become uneconomic in the foothills. Therefore, Pomegranate can become an alternative cash crop in the foot hill areas where apple cultivation has vanished due to non fulfillments of chilling hours owing to rise in minimum and maximum temperature during winter months.

Adoption of the innovation by other farmers in the village

Since innovation is highly profitable, most of the farmers in the village have adopted the practice and planted pomegranate orchards. The area under pomegranate cultivation has increased significantly in the last decade.

(Source- Source: KVK, Kullu)

Profitable diversification through tomato cultivation in Nerwa area of district Shimla

Scientists from KVK Shimla at Rohru conducted a survey of Nerwa area of Tehsil Chopal district Shimla for exploring the area for cultivation of off-season vegetable crops and observed that tomato can change the life of farmers in the area. Necessary interventions were initiated in the same year by organizing training camps on cultivation of tomato. Farmers' groups were organized and field trials were laid out. By seeing the progress and profitability of tomato production, more farmers were motivated to cultivate tomato in the area.

Problem

In the mountainous terrain of district Shimla of Himachal Pradesh, the farmers of sub- tehsil Nerwa of tehsil Chopal were growing traditional cereal crops like rice, wheat and maize. They used to face the vagaries of nature for their subsistence through production of these crops. The earnings were very less and hence the living standards were very poor. Due to this, unemployment was very high in the area. With a view to exploit the opportunities like favorable climatic conditions and abundance of man power, scientists of KVK Shimla with other line departments organized training camps on cultivation of tomato as cash crop and conducted field trials on farmers' fields. Few farmers of the area got motivated and initially seven farmers from different villages came forward and were adopted by KVK for tomato cultivation under critical supervision of the scientists.

Effect of technology Production

The Nerwa area of tehsil Chopal was under subsistence farming till 1999. After exploring the scope of tomato cultivation in the area in the year 1999, trainings were provided on cultivation of tomato and field trials were conducted on farmers' fields in collaboration with line departments for adoption of this venture by the farmers of the area. In the year 2000, around 150- 200 bighas were undertaken for the cultivation of tomato, which was increased to 3000 bighas in the year 2002 benefiting around 1800 families with a net return of around six crores. Upto 2006-07, the income increased to about 10 crores benefiting around 3000 families. The average yield of tomato in the area is around 500qt/ ha.

Economic gains (Per unit expenditure, gross income, net income, C: B ratio)

Tomato cultivation has become an integral part of people of Nerwa area. The per unit expenditure (per bigha) is Rs. 20,000/- with a gross and net return of Rs. 52,000/- and Rs. 32,000/-, respectively, and the C:B ratio comes to 1.60.

Suitability in the existing farming/ cropping systems

The cultivation of tomato as a cash crop was found suitable in the area and fitted well with the existing farming system. The area is totally diversified from traditional cereal crops to tomato getting high returns from the unit area. This has changed the economic status of the people of Nerwa area, which is evident from the change reflected in their living standards.

Acceptance of technology /process in terms of views of the farmers

Most of the farmers of Nerwa area and surroundings have started growing tomato as a cash crop, replacing traditional cereal crops earlier grown in the area. On receiving the high returns from tomato cultivation in comparison to traditional farming, cultivation of tomato has become the main stay and most popular component of farming in the area. The farmers have a keen interest in tomato cultivation and the impact of trainings and demonstrations was such that the movement which was started by about 7 farmers has now increased in numbers to about 5000 at present.

Acceptance of replacement of commodities

The change in farming system i.e from cultivation of cereals to tomato required the knowledge about its cultivation and availability of inputs. Initially, KVK scientists in collaboration with line departments provided trainings as well as made the availability of tomato hybrid seeds to the farmers. But once the produce started fetching returns, and the marketing of produce was explored, the farmers have started planning their schedules accordingly and procure all the requisites well in advance from the market. Horizontal spread in the year 1999. Then the intervention was initiated by organizing training camps on tomato cultivation, only seven farmers came forward, Later in 2000, a group of

150 members was constituted and on around 150- 200 bighas, tomato cultivation was carried out. In, 2005, when the area was visited, the data collected from different groups revealed that tomato of around 10 crores was supplied to various markets in the plains benefiting around 3000 families.

Source: KVK, Rohru

Mushroom cultivation as a source diversification and income generation

Diversification in any farming system imparts sustainability. To provide food and nutritional security to our people, it is important to diversify the agricultural activities in areas like horticulture. Mushrooms are one such component that not only impart diversification but also help in addressing the problems of quality food, health and environment related issues. Utilising agro-industrial wastes for growing mushrooms can enhance income and impart higher level of sustainability.



Due to lack of knowledge, farmers are unaware about its importance, nutritive value and cultivation. Farmers were motivated about the importance, cultivation and processing of dhingri, button and medicinal mushrooms through training programmes organised by KVK Scientists from 8 to 11 Feb, 2016. During the training programme, seed of dhingri was also provided to the farmers so that they can go for its cultivation at their own level whose results were found to be outstanding. Farmers are now taking interest in mushroom cultivation and KVK Scientists are regularly receiving phone calls regarding the procurement of spawn and its cultivation methodology.

Source: KVK, Rohru

Conclusion and Recommendations

Climate change has had significant implications for the agricultural sector in Himachal Pradesh. It equally identified the implications of climate change for policy and extension. The present project indicates that agricultural strategies for climate change adaptation are developed through policies and institutions which could reduce the vulnerability of the agricultural sector in Himachal Pradesh. It also highlights the critical challenges faced by Hilly areas in agriculture in trying to adapt to the problem of climate change. These challenges need urgent attention by the relevant authorities because of the fact that the problems of climate change are already on course. The strategies discussed, can each make important contributions, but there are no quick, technological shortcuts because the efficacy depends on the broader technological, economic, environmental, and political context.

The researcher conducted the study in all the sectors and found that there is no linkage between public and private sectors which causes gaps in dissemination of technology in a proper and effective manner.

The role of agricultural extension officers with the linkages of different sectors should be further explained to the farming communities in Himachal Pradesh. This must include Agricultural extension officers role in encouraging farmers to adopt new technologies, improved methods of farming, using a variety of methods to reach farmers that is, organizing study groups for farmers, farmer days, demonstrations, lectures and literature, as well as informing the media about farmers' challenges. Designing policies that aim to improve role of extension services in communities have great potential to improve farmer adaptation to changes in climate. Government policies need to support the training of extension officers so that they give farming communities relevant information about climate change adaptation.

However, with these hopes for improvements, the sensitivity of agriculture to climate change remains a global concern. Based on the project, the following recommendations were made:

(i) Institutional linkages should be fostered for agricultural sustainability

Since climate change could exacerbate rainfall variability, close collaboration between meteorological and agricultural services as well as other sectors will be necessary for a more effective use of climate forecasts. Extension services need to be strengthened and agents provided with the necessary equipment's and logistics so that they can reach farmers more easily with agricultural technologies for adaptation in the face of changing climate.

(ii) Development of Special rural micro-credit Schemes

Because of the lack of adequate rural financial facilities, small holder farmers have often been bypassed by new technologies. The agricultural bank that exists usually targets either big commercial farms or comes up with collaterals as pre-conditions for accessing such loans. As such the loans

should be free from interests and collaterals in order for the poor farmer to access and adapt to the impacts of the climate change.

(iii) Improved Extension and information delivery

Information delivery is critical in the process of enhancing the adaptive capacities of the rural areas to climate change. Information on weather or new technologies could be transmitted to the farmers using rural radio and other media and gatherings such as traditional ceremonies. The rapid development of mobile telephony is now opening up new opportunities and should be exploited fully to reach the otherwise remote and unreachable areas.

(iv) Existing technology options should be made more available and accessible

Climate change will almost surely make life even harder for the world's poorest and most vulnerable populations. Therefore, avoidance should be made in restricting their capacity to adapt by limiting their options. Technology options, in particular, should become more available.

(v) Human Capital Development

Agriculture needs to become professionalized with educational training incentives and development of human capital in the direction of crop and livestock production. There is a need for effective capacity to strengthen the most vulnerable group in agricultural production with requisite knowledge and information necessary for climate change adaptation.

(vi) Climate Change Adaptation Funding

Climate change adaptation funding should focus on extension systems and programmes that incorporate a good understanding of what practices and skills are needed to best promote activities that help in the climate change effort and on increasing the capacity of extension agents and farmers, where needed.

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