CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Agriculture is the backbone of Nepalese economy, it means, it is a source of livelihood for majority of the population and the main sources of GDP, income and employment generation. It is necessary to orient the nation towards industrialization by increasing the agricultural production by moldering and commercializing through equitable distribution. Its multiplier effect on non-agriculture sector also increases the employment opportunity. Since ten years agriculture development contributes a sustainable basis for poverty alleviation, it should be treated as the lead sector for national development and in order to push forward sector line industry commerce, water resource, transport and energy as supplement and supportive to the agriculture sector, a well co-ordinate long term approach is needed (APP, 1995). The development and enhancement of the productivity of this sector plays vital role in the productive employment generation and improving economic development of the country. The economy is dominated by agriculture, so that agriculture pays major role in the economy, which contributing 33.7 percent of the total GDP (MOF, 2014). And it is generally accepted that the key of economic development is agricultural products. Agriculture farming in Nepal is labor intensive. Economically active people lives in urban area, and who are economically weak lives in rural area doing agricultural farming.

Nepal is an agriculture-based country where more than 65% of the population engages in agriculture for livelihood and agriculture shares about 33% of its GDP at current price and 35% at 2000/01 constant price (MOAC, 2010). Weather variability comprising of intermittent drought, submergence, flood, intensive, hot and cold waves and irregular pattern of precipitation are considered as major parameters of changing climate having by and large adverse impacts in various aspects of agricultural system, its productivity and food security in different agro-ecological zones of the country (Pokhrel & Pandey, 2011). In the late 1980s, it was the livelihood for more than 90 percent of the population, although only approximately 20 percent of the total land area was cultivable, it accounted for, on average, about 60 percent of the GDP and approximately 75 percent of exports.

Since the formulation of the Fifth Five-Year Plan (1975–80), agriculture has been the highest priority because economic growth was dependent on both increasing the productivity of existing crops and diversifying the agricultural base for use as industrial inputs (Savada, 1991).

Nepal is divided in five major physiographic zones. They are Terai, Silwalik, Hilly, Middle Mountain and High Mountain. The elevated northernmost part of the High Mountain is also called Himalayas or Tibetan Plateau. The Terai, a long narrow belt of fertile agricultural flat land, is part of the alluvial Gangetic Plains and has altitudinal variations ranging from 60m to 300m. The Terai lies between the Indian border in south and the first outer foothills of Nepal in the north. The Siwalik range, 600m to 1500m in elevations, lies in the north of Terai region. This range is wider in the western and far-western parts than the eastern part of the country, which is mainly composed of sedimentary rocks and big boulders.

The intensive cultivation and decrease forest cover in combination has been causing a serious problems of soil erosion in these valleys. To the north of these valleys is the Mahavarat Range (2700m-3700m), which in terms of formation and elevation, is geologically more developed in eastern and central Nepal than western Nepal. It is composed of hard rocks such as granite or quartzite and limestone. To the northern most parts of Nepal is a snowy mountainous region (Himalayas) that lies above 4000m in elevation and screeches from east to the west of the country (Devkota 2004). A sharp topographical variations from 60m to 8848m within small distance of Nepal contributes to different climatic zones. Rapid changes in the altitude and aspect along the latitudes have made existence of wide range of climatic conditions in Nepal (Nayava, 1974). Temperature in Nepal varies mainly with topographic variations along south-north direction. Normally, the average temperature decreases by $6^{o}C$ for every successive gain in altitude by 1000m (Jha, 1992). The Terai Region is the hottest region of the country, the hilly region is relatively colder than Terai while the Mountain Region is the coldest one. The long term weather of a particular area is the climate. Generally, climate is the aggregate weather of 30 years. The any change in climate is the climate change. Hence, the climate change is the change in the aggregate statistical distribution of weather of long term duration of an area. Climate change can be indicated by studying different indicators like air temperature, precipitation, etc. Any change in such indicators suggests there in climate change. The climate change is a natural process but the rapid change in recent decades is anthropogenic. The main cause of climate change is emission of greenhouse gases. There are natural and anthropogenic sources of emission of greenhouse gases that cause climate change.

1.2 Statement of the Problem

In the context of Nepal, agriculture is an important and productive for the farmer and businessman. Nepal is agricultural country and has the wide range of climate within a small area. Agriculture is dependent on climate and weather and economy of the county is dependent.

On agriculture hence the economy is very much influenced by climate and weather. The change in any parameters of weather can change the agriculture production and the economy of the country. The weather also has effect on the development works of the country. As Nepal has vast topographical variation, there are risks of floods, landslides and other climatic disasters. To minimize the risk of natural disasters and to adopt mitigating measures, the detail study of climatic pattern is must.

The primary source of livelihood of Nepali people is agriculture. More than 80 percent of people depend on agriculture for income and employment; has large contribution in GDP of the country. Growth in production and productivity in the agricultural sector plays an important role in the socio economic condition of people (NPC, 2008).The agriculture production is dependent on the climate and weather. The change in any meteorological parameter can highly reduce the agricultural production. The parameters like temperature, rainfall, wind speed and direction, sunshine duration and intensity, relative humidity and others play important role in plant's physical development. The global climate is changing hence the meteorological parameters are also changing. So the detail study of climate change and meteorological parameters is must for the better production.

1.3 Objective of the Study

The general objective of this study is to find the effect of climate change on agricultural production in the hilly region of Nepal. The study is focused in a single village: Mahadetar Kavre. The study aims to find the proper adaptation techniques in agriculture for changing climate. The specific objectives of this study are:

i) To evaluate the farmer’s knowledge on climate change in Mahadevtar VDC, Kavre
ii) To analyze the impact of climate change on agricultural production and adaptation techniques in the study area.

iii) To Analyze of adaptation techniques used in Mahadevtar VDC.

1.4 Rationale of the Study

Agriculture is affected the most by this change, which poses the threat to food security of nations and livelihoods of millions of farming communities.

Climate change has become an issue for discussion on various seminars, conferences etc. and had been the global environmental challenge. Thus, it has become necessary to know about the climate change and its impact on agriculture and the adaptation measures. So, this research will help to know about how people perceive and how they has been affected. Moreover, to mitigate the problem what the tools and techniques are, measures, strategies that the farmers are adapting and whether they are affordable to the local people is equally important to understand the whole process.

1.5 Limitations of the Study

The study is limited to Mahadevtar VDC of Kavre district. Though the result obtained from this research can be generalized to other location of same climate but many other factors also affects the agriculture production. The climatic data taken in the study is from Kavre district headquarter. Though this climate data give the similar trend but does not accurately represent the climate data of the study area.

1.6 Organization of the Study

This study is divided into five chapters. The first chapter is introductory which includes background of the study, statement of the problem, objectives, significance of the study, limitation and organization of the study. The second chapter deals with reviews of literature. Third chapter is concerned with methodology of the study, which included the research design, Rational of the study area, nature and source of data, Universe and sample, data collection techniques and tools and methods of data analysis and interpretation procedure. Chapter five mainly concerned with summary conclusion and recommendation are included.

CHAPTER TWO

LITERATURE REVIEW

This chapter deals with the literature review. The review of literature is a critical evaluation, analysis and synthesis of existing knowledge relevant to our own research problem. It is useful to develop new ideas and analytical methods in research. Through the review of related literature, the researcher gains different kinds of information and experiences from the works of others. To conduct this research some relevant literatures have been reviewed which help researcher to address research issue systematically. For this research study, following relevant studies have been reviewed.

2.1 Climate Change

Agriculture development has getting top priority in all the five-years plans. Different theoretical model have been employed as if Nepal is one of the experimental sites to verify the models whether they actually work. Nepal is established as a heavily aid receiving developing country. Thousands of foreign experts and Nepalese elites have exercised for agriculture development. Donors have supported us in Generating technologies and extending them widely in rural communities. Their interest also has been shaping our development in many ways. Different approaches and strategies were employed for manpower and technology development and for wider research and extension.

The global and national data clearly show that the numbers of natural disaster events are increasing in recent years. Socio-economic and environmental losses caused by these natural disasters are also increasing. The increasing trend of all type of natural disasters noticeably reveals that highest portion of natural disasters is contributed by climate related disasters compared to other kind of disasters (UNISDR, 2005).

Analysis of precipitation data from station records all over Nepal does not reveal any significant trends. However, an analysis of daily precipitation data for 46 years from 1961-2006 shows an increasing trend in precipitation extremes. About 73% stations (out of 26 total station selected for the study) exhibited an increase in the annual count of days when precipitation is greater or equal to 50 mm (Baidya et al., 2008).

In the policy and legislative front also, Nepal initiated several measures. It brought Sustainable Development Agenda for Nepal in 2003 to guide the sustainable development path till 2017. Other several policies, strategies, and laws which are relevant to the issues of environmental problems and climate change have been put into force. The major national environmental policies include the National Conservation Strategy, 1988, the Nepal Environment Policy and Action Plan, 1993, the Sustainable Development Agenda 2003. The climate change policy is prepared and in the process of finalization. The Interim Constitution of Nepal, 2006, has, for the first time, recognized "right to clean environment" as a fundamental right of the citizens of Nepal. Environment Protection Act, 1996, Environment Protection Regulations, 1997 and Climate Change Action (formulated), 2066 are the key environmental legislations. The other legislations include Soil and Water Conservation Act, 1982; Water Resources Act, 1992; Industrial Enterprises Act, 1992; Vehicle and Transport Management Act, 1992 and Regulations, 1997 (with first amendment in 2004); Forest Act, 1992 and Regulations, 1995; Local Self-governance Act, 1999 and Local Self-Governance Regulations, 1999 and Ozone Depleting Substance Consumption Regulations, 2001.

The largest number of national records for 24-hour extreme precipitation events, as reported in the WMO survey, occurred over the past two decades, 1991-2010. Global land-surface precipitation averaged over 2001-2010 was above the 1961-1990 average. It was the wettest decade since 1901, except for the 1950s. In addition, 2010 was the wettest year ever recorded at global level. The previous wettest years were 1956 and 2000 (WMO 2013).

The Intergovernmental Panel on Climate Change (IPCC), a group established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), reports that the average surface temperature of the earth has increased during the twentieth century by about 0.6° ± 0.2°C. WMO, in its Decadal Global Climate Summary, 2001-2010, characterized the decade 2001-2010 a record in global temperature increase since sufficiently comprehensive global surface temperature measurement began in 1850. This trend is confirmed at national level where 96% of the countries had their warmest decade in 2001 to 2010 and 4% in 1991 to 2000. Nine of the decade's years were among the 10 warmest on record. The warmest year ever recorded was 2010, with a mean temperature anomaly estimated at 0.54^{O}C above the 14.0^{O}C

baseline. The warmest worldwide land-only surface-air temperature was recorded in 2007, with a temperature anomaly of +0.95^{O}C (IPCC 1996).

Many studies had been carried out in the precipitation of Nepal. Most of the study results showed that Summer Monsoon brings about 80 percent of annual rainfall in Nepal during the rainy season of Nepal. The rainy season of Nepal includes the months of June, July, August and September. Other 20 percent of annual rainfall is predominantly released by western disturbances. According to Nepal Hydrological and Meteorological Research Center and Consultancy P. Ltd., the mean annual precipitation of Nepal is around 1800mm. The annual trend in precipitation all over the country is 0.7mm/yr (DHM 2015).

In Nepal, in between 1995 to 2002, the totals of 6854 lives were lost by the landslide and flood disasters (ADB/ ICIMOD, 2006) with billions of dollars economic loss of land and infrastructures. In total more than 500000 people were killed by landslides in the 20th century globally. In first 25 weeks of 2003, there were 2000 landslides fatalities in 139 large events, 95% of which occurred in less developed countries (ADB/ ICIMOD, 2006). Because of its location in the central part of the Himalayas and with its fragile geology, steep slopes, high relief, and intense monsoon climate, Nepal is prone to water induced disasters such as flood and landslides. Over the last twenty years from 1983-2002, flood and landslide caused 6466 deaths and more than US $200 million in damage. In 1993 alone there were more than 1300 lives lost and over US $ 2 million of property and infrastructure destroyed by an individual event recording the highest 24-hr precipitation of 540mm (ADB/ ICIMOD, 2006).

The seasonal mean rainfall is highest (1277mm) during summer monsoon season and lowest (67 mm) during winter. SMR series has seasonal highest of 1530 mm (1975) and lowest of 990 mm (1992) rainfall. Whereas during winter season, the highest amount of 134 mm (1962) and the lowest amount of 11 mm (1967) is observed. But, the variability is found highest (65%) during post-monsoon season and lowest (9%) during monsoon season (Devkota, 2004).

Shrestha et al. (2000) studied on the precipitation fluctuations in the Nepal Himalayas and its vicinity and relationships with some climatological parameters. They studied precipitation records from 78 stations distributed across the Nepal (1948-1994). The all-

Nepal and regional precipitation series showed significant variability on annual decadal time scales. Distinct long-term trends were not found in these precipitation records.

Adhikari (2003) studied on the daily, monthly and seasonal rainfall climatology during summer monsoon at Pokhara, Kathmandu, Okhaldhunga and Dhangadhi using the daily rainfall data of those stations. In his studies, 1972,1977,1980,1981, 1982 are the drought year.

Neupane (2016) studied about the climatic pattern of Kavre. The conclusion of the report suggests there is significant change in the temperature and rainfall pattern in Kavre. The higher increase is observed in the maximum temperature. There is much more increase in the average maximum temperature than the minimum temperature. Though the minimum temperature has also been increased but the increase is less compared to the maximum. The average increase is 0.44 degree Celsius per decade. There is not much difference in the average temperature in the decades of seventies and eighties but the rapid increase in temperature followed in the decade 1990s.

The precipitation extremes show increasing trend in total and heavy precipitation events at most of the stations. However, the systematic difference is not observed in extreme precipitation trend between hills and low land southern plains of terai. The evidence suggests complex processes in precipitation extremes, but at the same time there is indication that more weather related extreme events like floods, landslides can be expected in future (Baidya,et al. 2008).

There have been many studies on the temperature trend of Nepal. The past studies and observed data shows the temperature is minimum in winter season and maximum in last pre-monsoon and monsoon season. The Terai region experiences more than 40^{o}C in summer while the negative temperature is common above the Snow Belt region of Mountain region. Most of the maximum temperature series show increasing trend, except the TS and all-Nepal series during pre-monsoon season where slight decreasing trends are observed. Whereas, most of the seasonal and annual minimum temperature series for HM region and all-Nepal show decreasing trend and these for TS and HMM regions show increasing trends. The highest increasing of maximum temperature trend of 0.4^{o}C/decade is observed over HMM region during the post-monsoon. The highest increasing and decreasing trends

of minimum temperature of 0.37 and 0.57 ^{O}C/decade in winter season are observed over HM region in annual and TS series, respectively (*Devkota, 2004*).

Baidya et al. (2008) studied the trends in the daily climatic extremes of temperature and precipitation of Nepal. The daily temperature data of for 36 years from 1971 to 2006 of Nepal were analyzed. General warming trend had been observed in the temperature extremes. General increasing trend has been observed in the temperature extremes. Most of the temperature extreme indices show a consistent different pattern in the mountainous and the terai belt. The trend is of relatively higher magnitude in mountainous region. Such pattern may be associated with the occurrence of prolonged fog in the terai region. Days and nights both are becoming warmer and cool days and cool nights are becoming less frequent (Baidya et al.2008).

Sharma et al. (2000) studied anthropogenic, climatic and hydrological trends in the Koshi Basin, as representative of the Himalaya, the analysis of meteorological time series from 1947 to 1993 showed some increasing tendency of temperature.

PAN (2009) found a general increasing trend in temperature has been found over Nepal based on data from 1976 - 2005. The maximum temperature was found to be increasing at a greater rate (0.05° C/year) than the minimum temperature (0.03 °C /year). A decreasing trend was found in maximum temperature in Terai region during winter season. Mean annual maximum temperature in Terai belt reached above 30 °C which gradually decreased towards North. In Siwalik range, the mean maximum temperature varied between 26 °C to 30 °C. The mean maximum temperature ranged between 22 °C to 26 °C in the middle hills regions and reached below 22 °C in the high hills and the Himalayas or the mountains.

Shrestha et al. (1999) studied on the maximum temperature trend in the Himalaya and its vicinity using maximum temperature data from 49 stations in Nepal for the period of 1971-1994. Warming tends of maximum temperature was observed after 1977, ranging from 0.068 to 0.128 ^{O}C/year in the most of the Middle Mountains and Himalayan regions.

A report by Ministry of Environment, Climate Change Vulnerability Mapping for Nepal, 2010, states the overall climate change risk trend which includes precipitation and

temperature parameters is very high (0.442-0.579). The landslide risk is also high (0.358-0.556) (MOE 2010).

2.2 Impact of Climate Change in Agriculture

In Nepal, the diversified climatic conditions are suitable to produce various types of crops, including vegetables during different seasons. At present, more than two hundred vegetable species are grown in different places under various climate zones of Nepal. Experiences have shown that commercialization of existing farming practices with adoption of technologies for off-season vegetables production can improve the livelihood of the farmers. (MEDEP, 2010).

While overall food production may not be threatened, those least able to cope will likely bear additional adverse impacts (WRI, 2005). The estimate for Africa is that 25–42 percent of species habitats could be lost, affecting both food and non-food crops. Habitat change is already underway in some areas, leading to species range shifts, changes in plant diversity which includes indigenous foods and plant-based medicines (McClean, Colin *et al*., 2005).

The major cause of climate change is the change in the concentration of carbon dioxide and other greenhouse gases in the atmosphere which help in the change in temperature of the earth by absorbing more radiation. The change in the concentration of carbon dioxide has direct effect in agriculture as carbon dioxide is taken by plants for photosynthesis. The change in temperature of the earth has effect in production life as temperature plays important role through germination to its final stage.

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Climate change affects agriculture in a number of ways, including through changes in average temperatures, rainfall, and climate extremes (e.g., heat waves); changes in pests and diseases; changes in atmospheric CO2 and ground-level ozone concentrations; changes in the nutritional quality of some foods; and changes in sea level (Wikimedia Foundation, 2016).

Climate change is already affecting agriculture, with effects unevenly distributed across the world. Future climate change will likely negatively affect crop production in low latitude countries, while effects in northern latitudes may be positive or negative. Climate

change will probably increase the risk of food insecurity for some vulnerable groups, such as the poor (Wikimedia Foundation, 2016).

Agriculture contributes to climate change by (1) anthropogenic emissions of greenhouse gases, and (2) by the conversion of non-agricultural land (e.g., forests) into agricultural land. Agriculture, forestry and land-use change contributed around 20 to 25% to global annual emissions in 2010 (Wikimedia Foundation, 2016).

A report released by International Food Policy Research Institute (IFPRI) says due to climate change, the food production will be less. In the countries where already the price of food is high, the more increase in price of food may cause social violence. This type of violence is proving to appear in the poor countries like Zimbabwe and Nepal where the inflation of money is higher. IFPRI suggested that twenty-five million more children will go hungry by the middle of this century. The children of 2050 will have fewer calories to eat than those in 2000. In the countries, where adequate injection of funds and new technology are not available, wheat yields could fall by more than 30%, setting off a catastrophic rise in prices. Wheat prices, with unmitigated climate change, could rise by 170%-194% by the middle of this century. Rice prices are projected to rise by 121% and almost all of the increase will have to pass on to the poor consumers poor countries. According to the same report, people in both the developing and developed countries will have to less to eat by 2050 if climate change is not seriously addressed, through the short fall will be relatively slight in richer countries. In 2050 the calories 20 available for each person in industrialized nations will fall from 3,450 in 2000 to about 3,200.In developing countries overall, the average will fall from 2,696 to 2,410 calories. In sub-Saharan Africa, people will on average have only 1,924 calories a day, compared with 2,316 in 2000.In this condition, there can be social violence for the gain of food. If the climate change is not seriously addressed, we cannot say it is not possible the arrival of time, when on man kills other man for killing his hungry. So climate change also creates negative effect on human security (Msangi & Rosegrant, 2008).

The world food trade model estimated that in 1980 there were about 500 million people at risk of hunger, in 2060 it has been estimated to be 640 million, however with unmitigated climate change it has been estimated to be at 700 million. Declines in yields in low altitude regions (where many developing countries are located) are projected require to imports large amount of cereals. The number of hungry people in developing countries will increase by 1% for any 2-2.5% in increase in prices. This means the number of peoples at

risk of hunger grows by 10-60% in the scenarios tested, resulting an estimated increase of 60 to 350 million people in this condition (Rosenzweig & Parry, 1994).

Agricultural production and biophysical, political and social systems that determine food security in Africa are expected to be placed under considerable additional stress by climate change (FAO, 2011).

Climate variability driven by major inter annual-scale climate modes, such as the El Nino Southern Oscillation, has been playing a key role by often leading to droughts and decrease in crop yields that could further result in famine in some food insecure regions. For example, droughts in the United States in 2012, heat waves and associated Russian wheat embargo in 2010/2011, and droughts in Australia in 2006/2007 and 2007/2008 led to low levels of cereal stock and steep increases in food prices, likely worsening the access to affordable food for many consumers, including the poor in import-dependent countries (FAO, 2011). Ongoing climate change and associated changes in the intensity, frequency and duration of weather/climate extremes, in conjunction with growing population, dietary shift and increasing bio-fuel demand, are additional concerns for 21global food security. For example, Lobell and Gourdji in their article The influence of climate change on global crop productivity published on 2012 in Plant Physiology Preview for Department of Environmental Earth System Science and Center on Food Security and the Environment, Stanford University estimated that climate change from 1980 to 2008 has already reduced global production of maize by 3.8% and wheat by 5.5% relative to a counter factual without climate change (Iizumi & Navin, 2015).

In Nepal, 64 percent of cultivated land is fully dependent on monsoon rainfall and hence agricultural production is vulnerable to change in nature, time and duration of monsoon rainfall (Dhakal, 2003). Agricultural production would suffer severe losses due to heat stress, longer dry season, uncertain rainfall and degradation of land with adverse consequences of food security.

Changes in water and flow regime are found the most critical under anticipated changes in climate system. Water related disaster, flood, drought, erosion, and landslide may occur with greater frequency in future, directly affecting the land. The population in Terai, plains and hilly areas is more vulnerable than in other areas (Alam & Regmi, 2004).

2.3 Adaptation Measures to Climate Change

Agricultural outcomes are determined by complex interactions among people, policies, and nature. Crops and animals are affected by changes in temperature and precipitation, but they are also influenced by human investments such as irrigation systems, transportation infrastructure, and animal shelters. Given the uncertainties about where climate change will take place and how farmers will respond, much is still unknown about the effects of climate change on agricultural production, consumption, and human well-being, making it difficult to move forward on policies to combat the effects of climate change (N.C. Gerald, 2009).

Adaptation is the responsive adjustment in natural or human managed systems to minimize the impacts, effects or expected changes. IPCC has categorized adaptations in two types; spontaneous and planned. Spontaneous adaptation occurs at the level of individual whereas planned adaptation need involvement of society with guiding policies (Berry, et al., 2006). Adaptation on agriculture can be categorized as: technological, on-farm adjustment practices, government policy including insurance as well as diversifying household income sources as financial management strategies. In fact, the farmers who have the resources and access should be able to adapt better as compared to resource poor marginal farmers (Esterling & Apps, 2005). Famers can adopt to climate change to some extent by adjusting planting time and input use, by 31 altering soil management practices as well as diversifying their farm enterprises (Smit & Skinner, 2002).

According to the fourth assessment report of IPCC, adaptation measures are classified as (a) technological: building protective infrastructure like river and sea dykes; (b) behavioral: changing food and recreational choices; (c) policy: implementing new regulations (IPCC, 2007).

Intensifying food production systems, improving land, water and forest management, enabling policies and regional cooperation and strengthening research for enhancing adaptive capacity can be the major key elements for assisting farmers in coping with current climatic risks in South Asia (Shivakumar & Aggarawal, 2008).

In Limpopo River Basin of South Africa, as responses of the farmers to increased temperature, the adaptation measures like changing in crop varieties, changing the planting

dates, increasing irrigation and investing on livestock have been adopted (Gbetibouo, 2009). In South Asian countries, particularly India, Nepal and Bangladesh, farmers are already adapting to changing conditions by using traditional seed exchange practices that are part of established seed systems (Gautam, 2008). Farmers can also use their knowledge of abiotic stress tolerance and adaptability in their materials and work with plant breeders to develop varieties that are adapted to changing local conditions and possess improved yields and quality (Devra & Brown, 2008). Many adaptation practices involving crops and livestock have been reported. Climate variability and risks have always been a part of agriculture, due to which farmers have developed many ways of managing risks. Searching and exchanging drought-resistant seeds and other abiotic stress-tolerant crop varieties and adopting and practicing specific soil and water management practices for marginal areas have long been core activities of the farming communities (Gautam & Pokhrel, 2011).

A number of negative effects of Climate change like change in Agricultural Calendar, vegetation shifts, change in routine activities like grazing, harvesting and storing etc. have been observed in Agriculture in Nepal. Over the past three years, the delay in monsoon season experienced in Nepal has changed the cropping pattern and crop maturity period which has delayed the planting and harvesting season by a month, which has in turn affected rotation practices (Dahal, et al., 2011). The delay in monsoon season has also made thousands of hectares of farm land fallow and reduced production due to lack of water (Regmi & Adhikari, 2008).A drought in the Eastern region of Nepal decreased the rice production by 30% in 2006 and heavy flooding in the mid-Western and far-Western regions in 2006 and 2008 destroyed crops in many places and there is also evidence that the vector borne diseases in livestock are increasing, forcing the livestock population to move to higher altitudes (Practical Action , 2008).

An adaptation measure to climate change has been developed by Government of Nepal (GoN). GoN developed APP covering 20 years (1997/98 - 2016/17), which has been implemented under four periodic plans for the development in agriculture and agriculture based trade industries. GoN developed APP covering 20 years (1997/98 - 2016/17), which has been implemented under four periodic plans for the development in agriculture and agriculture based trade industries (Thapa, 2011).

Climate change has direct effects on livestock productivity as well as indirectly through changes on the availability of fodder and pastures. Climate determines the type of

livestock most adapted to different agro-ecological zones and therefore the animals that are able to sustain rural communities. Climate change is expected to affect livestock at the species level. For example, if the Himalayas turn warmer, the yak could be restricted to higher altitudes where grass and fodder is less available. Communities will seek other species for production, relying on their own knowledge.

The global and national data clearly show that the numbers of natural disaster events are increasing in recent years. Socio-economic and environmental losses caused by these natural disasters are also increasing. The increasing trend of all type of natural disasters noticeably reveals that highest portion of natural disasters is contributed by climate related disasters compared to other kind of disasters (UNISDR, 2005).

Global warming, the quicker warming of the earth enhanced by greenhouse effect, has ultimately brought unavoidable climate change consequences. Warming of the climate system is now unequivocal. It is now clear that global warming is mostly due to man-made emissions of greenhouse gases mostly CO2 (UNFCCC, 2001).

Vulnerability of the system is "a function of the character, magnitude, and the rate of climate variation to which a system is exposed (IPCC, 2007). In disaster planning, vulnerability is the social, economic and environmental exposure and sensitivity. For community and people adaptation is the process of social learning too. Adaptive capacity is the ability to understand climate changes and hazards, to evaluate their consequences for vulnerable peoples, place and economies and to moderate potential damages to take advantage of opportunities, or to cope with the consequences (Dow & Downing, 2006).

The increases in average global temperature (global warming); changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and increases in ocean temperatures and ocean acidity – due to seawater absorbing heat and carbon dioxide from the atmosphere (UNFCCC, 2007) clearly indicates the changing trend in climate. Over the last century, atmospheric concentrations of carbon dioxide increased from a pre-industrial value of 278 ppm to 379 ppm in 2005, and the average global temperature rose by 0.74° C (UNFCCC, 2007) which supports the fact the global increase in the temperature is mainly due to the excess emission of CO2 from human induced sources.

The potential impacts on rain fed agriculture vis-à-vis irrigated systems are still not well understood. The developing world already contends with chronic food problems. Climate change presents yet another significant challenge to be met. While overall food production

may not be threatened, those least able to cope will likely bear additional adverse impacts (WRI, 2005).

Agricultural outcomes are determined by complex interactions among people, policies, and nature. Crops and animals are affected by changes in temperature and precipitation, but they are also influenced by human investments such as irrigation systems, transportation infrastructure, and animal shelters. Given the uncertainties about where climate change will take place and how farmers will respond, much is still unknown about the effects of climate change on agricultural production, consumption, and human well-being, making it difficult to move forward on policies to combat the effects of climate change (N.C. Gerald, 2009).

Rice is the second important crop in the world with production of about 525 million tons from about 148 million hectors. It is cultivated within an altitude of 300-2300 meter above sea level. In south Asia, rice production has to be doubled by the year 2020 (IRRI, 2000). Study on increased CO2 and temperature in NARC at Khumaltar shows the increase of rice yield by 17.07 and 26.58% even at the increase in temperature in chamber by 6.2oC and 7. Greenhouse effect due to doubling carbon dioxide was observed by 1.16oC and produced 9.51% higher than ambient plots. Nitrogen content of the rice was increased by 16.3% due to rise in temperature, but decreased by 9.8% due to doubling of CO2 (Malla G, 2008).

The APP's target was to increase agricultural growth rates from the past (1964/65-94/95) trend of 3.97% or no-APP case of about 3.26% to 4.75 % annually. The APP showed a slight commodity bias in agricultural planning putting a higher emphasis on the high value agricultural commodities (HVAC) and less on staple foods. APP thus slightly downplayed the importance of self-sufficiency in food grains which may be a questionable strategy. The APP growth accounting framework (GAF) estimated that of the total AGDP, crops would contribute 50% and the rest would come from livestock, forestry, and fishery. APP tried to increase AGDP with contributions from inputs to the extent of 57.6%, namely fertilizers 38.2%, variety 3.4%, and irrigation 16.01% (surface water 7.86%, groundwater 11.56%, and others 3.39%). Thus, the APP mainly targeted HVAC growth through seed-water-fertilizer technologies and trade for food security (Thapa, 2011). The government

too has planned for improved seed, fertilizers, technological development and irrigation facilities in order to increase the food production in agriculture.

Agricultural and socio-economic development is such development that is people centered, concentrating on improving the human condition, and conservation based, maintaining the variety and productivity of the nature. In this context, new options need to be researched to broaden the non-chemical approach of farming, directed towards ongoing problems of continuous agricultural production (Ghimire, 2005).

The scenario of the global change impacts in the fragile mountains of Nepal and around is greater, the major impacts and threats of global warming are widespread. As a result of global warming, the type, frequency and intensity of extreme events, floods, droughts and heavy precipitation events, are expected to rise even with relatively small average temperature increases. Changes in some types of extreme events have already been observed, for example, increases in the frequency and intensity of heat waves and heavy precipitation events (Meehl, et al., 2005) and such events bring more risk to the people living near to riverside or the marginal community.

The increases in average global temperature (global warming); changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and increases in ocean temperatures and ocean acidity – due to seawater absorbing heat and carbon dioxide from the atmosphere (UNFCCC, 2007) clearly indicates the changing trend in climate. Over the last century, atmospheric concentrations of carbon dioxide increased from a pre-industrial value of 278 ppm to 379 ppm in 2005, and the average global temperature rose by 0.74° C (UNFCCC, 2007) which supports the fact the global increase in the temperature is mainly due to the excess emission of CO2 from human induced sources.

Department of Hydrology and Meteorology as a focal point to IPCC maintains nation-wide networks of 337 precipitation stations, 154 hydrometric stations, 20 sediment stations, 68 climatic stations, 22 agro-meteorological stations, 9 synoptic stations and 6 Aero-synoptic stations. DHM analyzes the observed results and publishes them regularly and also maintains database. Considering the extreme topographic characteristics and dense network of streams, the network of meteorological and hydrological station are not

representative of the natural processes and there is a great need to strengthen the network (*www.dhm.gov.np*).

Increased intensity and frequency of storms, drought and flooding, altered hydrological cycles and precipitation variance have implications for future food availability. The potential impacts on rain fed agriculture vis-à-vis irrigated systems are still not well understood.

The developing world already contends with chronic food problems. Climate change presents yet another significant challenge to be met. While overall food production may not be threatened, those least able to cope will likely bear additional adverse impacts (WRI, 2005). The estimate for Africa is that 25–42 percent of species habitats could be lost, affecting both food and non-food crops. Habitat change is already underway in some areas, leading to species range shifts, changes in plant diversity which includes indigenous foods and plant-based medicines (McClean, Colin *et al*., 2005). In developing countries, 11 percent of arable land could be affected by climate change, including a reduction of cereal production in up to 65 countries, about 16 percent of agricultural GDP (FAO Committee on Food Security, Report of 31st Session, 2005). Changes in ocean circulation patterns, such as the Atlantic conveyer belt, may affect fish 19

Populations and the aquatic food web as species seek conditions suitable for their lifecycle. Higher ocean acidity (resulting from carbon dioxide absorption from the atmosphere) could affect the marine environment through deficiency in calcium carbonate, affecting shelled organisms and coral reefs. Crop productivity is projected to increase slightly at mid- to high latitudes for local mean temperature increases of up to 1-3°C depending on the crop, and then decrease beyond that in some regions (IPCC, 2004).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Design

Methodology is the hardcover of the study. So it needs to be empirical defined to conduct the study. Thus in this study the following methodology has been addressed to fulfill the objective.

3.2 Rationale of the Selection of the Study Area

A part of Central (Madhyamanchal) Bagmati zone, is one of the seventy five district of Nepal. Also a part of province no. 3. The district with Dhulikhel as its district headquarters, covers an area of 1,396km. sq. and has a population 2011 of 381,937. Lower tropical below 300 meters, percentage of area 0.1%, upper tropical elevation range is 300 to 1,000 meters, and 23.6% of area, subtropical elevation range is 1,000 to 2,000 meters, area of 65.3%. And also Temperate evetion range is 2,000 to3,000, its area percentage 9.6. The weather never becomes too hot and neither becomes too cold. The summer months are warm, post-monsoon are cool and winter are cold. The major population includes Tamang/Lama (Sherpa), Chhetri, Brahmin, Newar, Thakuri etc. Thus the study was based on the diversified place and the results can be applied to many places where different caste people live.

3.3 Nature and Sources of Data

The study has been based on both qualitative and quantitative data. This study attempted to explore the community level knowledge of on environmental changes and its effect on crops production along with the adaptations strategy used by farmers for better production. The quantitative data is reflected on table and figures, whereas the qualitative data is used for analysis.

3.4 Sampling Procedure

The universe of the study included the people of Mahadevtar VDC of Kavre district. The size of the Universe consisted 80,720 households (CBS, 2011). For collecting the reliable data, the purposive sampling method is applied. The households from different wards of Mahadevtar VDC were selected purposively in order to conduct household survey. The respondents were selected from those who had been settled there for a long period and whose primary occupation is agriculture. Altogether 50 respondents from different households related randomly were taken as sample size of the study.

3.5 Data Collection Techniques and Tools

To collect primary data, the structured questionnaire, semi or unstructured interviews and observations methods was applied. The researcher used the structured questionnaire, semi or unstructured interviews to collect primary data. Data was collected through household survey, and key informant interview. Additionally, observation methods was applied during data collection for analyzing the data. Likewise, for collection of secondary data, various books, online journals, research papers, newspapers, reports and related sources were referred.

3.5.1 Household Survey

To generate accurate and realistic data structured questionnaire was prepared and asked to fill up by local people, where as those respondents who were unable to fill up the questionnaire, the questions were asked to the respondents and the answer was filled up to collect the required information.

3.5.2 Key Informant Interview

The primary data was collected from the key informants using the semi or un-structured questionnaire interview method. The interview was taken as cross checking for data obtained from questionnaire.

The informants were interviewed on the knowledge of climate change, its impact in agriculture and adaptation measures used in study area. Those informants were the people involving in agriculture, government officer working in agricultural office, people involved in development of agriculture, and village representative.

3.6 Method of Data Analysis

Data collected had been analyzed with the help of computer program, where the researcher used simple statistical tools like table, graphs. For data analysis, descriptive methods was used for qualitative data.

3.7 Limitation of the Study

This present study was based on and limited to the climate of Kavre and people of Mahadevtar village of Kavre district. The study seemed to be very specific like that of case studies. So, the conclusion drawn from the study might not be conclusive. The conclusion might not be generalized for the whole. But the interferences might be valid to some extent to those areas, which have similar geographic, socio-economic and environmental settings.

CHAPTER IV

DATA PRESENTATION AND DATA ANALYSIS

4.1 Profile of respondent

In this chapter, It is analyzed the collected data regarding the objectives. The respondent were selected so that many of the research question are answered. The respondents should have engaged in agriculture, they should have the knowledge of past agriculture, past climate and other aspect of that village. Followings are the detail profile of the respondents.

4.1.2 Age group

Age determines the participation of the people in any work and so does in farming. The respondents were found as different age group. The age structure of them is presented in following table.

Table 4. 1 Age Group of the Respondent

S.N	Age Group	No. of Respondent	Percentage
1	Below 30 years	2	4
2	31-60 years	42	84
3	Above 60 years	6	12
4	**Total**	**50**	**100**

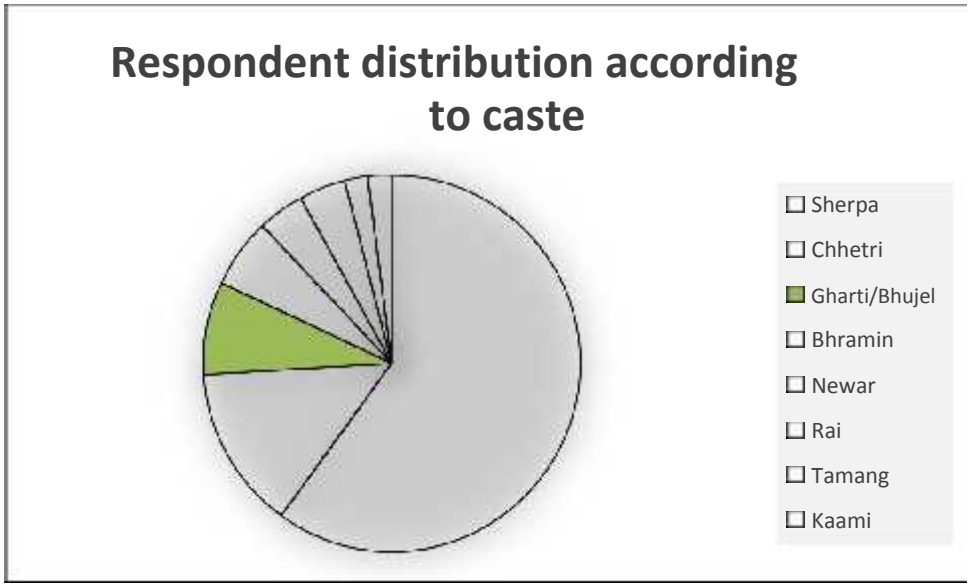
Source: Field Survey 2017

Table 4.1 shows that the majority of the respondent are above 31 years. The 84 percent of the respondent are of age group of 31-60 years, 12 percent are of age above 60 years and only 4 percent are of age below 30 years. The excessive majority of respondent lie in the age group of 31-60 years as the study aims to collect much information as possible. The concept of selecting so much people on that age group is that those peoples have lot of knowledge in agriculture and past climate and also have some knowledge about climate change and modern agriculture practices and climate change adaptation techniques in agriculture.

4.1.3 Caste/ Ethnic Composition

Caste is a social phenomenon which distinguishes one person from another on the basis of ethic based variables. Different castes are residency on the study area. In Mahadevtar VDC, more than ten caste people have their presence in total population while Sherpa being the dominant caste with almost 56% of the population of village. Other major castes are Chhetri, Bujhel/Gharti, Bhramin, Newar, Tamang, Rai and Kaami. The pie-chart (fig 4.1) given below show the caste distribution of the respondent.

Fig 4. 1 Caste composition of the respondent



Source: Field Survey 2017

The above pi-chart (Fig 4.1) shows that majority (60%) of the respondent are Sherpa. Other respondent are Chhetri (14%), Gharti/Bhujel (8%), Bhramin (6%), Newar (4%), Rai (4%), Tamang (2%) and Kaami (2%).

4.2. Farmer's Knowledge on Climate Change

Climate change is vague subject. Different people take differently for climate change. Some people do know what climate change is, some people think they know but they have not good knowledge in climate change and some people really know what climate change is. Here, in the field survey, people were asked whether they know about climate change

and the parameters of climate change differently for different parameters of climate and impact on agriculture.

4.3 Perception towards climate change

Every local does not have knowledge of climate change. Some people feels the present changing parameters of climate are due to climate change, some people think it's a natural variation process and some people even do not consider the change of climate parameters. Table 4.2 shows the data of local about their perception of climate change knowledge.

Table 4. 2: Farmers perception on their knowledge in climate change

Knowledge about climate change	
Yes	No
46	4

Source: Field Survey 2017

The Table no. 4.2 suggests that most of the local people think they know about the climate change. Among the 50 respondents, only 4 people replied that they do not know what climate change and 46 respondent i.e. 92% people know about climate change on their perception. Table 4.4 shows their perception on climate of Mahadevtar Village.

Table 4. 3: Farmer's perception of climate change

Is Climate Change has occurred in Mahadevtar Village?		
Yes	No	Do not know
40	6	4

Source: Field Survey 2017

Table 4.3 reflects that there is climate change in the present context and it has impact in Mahadevtar, Kavre. 80% of the respondent said that there is climate change, 12% replied there is no climate change and normal climate is going and 8% replied they do not know.

4.3.1 Perception towards rainfall

Among the different parameters, rainfall in one of the major indicator of climate change which has significant impact on agriculture, especially where there is no alternative or poor system of irrigation for agriculture. Nepal's agriculture is highly dependent on rainfall and

Mahadevtar Village of Kavre also highly depends on rainfall for the agriculture. The change in rainfall volume, intensity and pattern greatly affects the agricultural production.

This researched aimed to know the thinking of local people towards the rainfall patterns as climate change parameter. Table 4.3 shows the local people's perception towards rainfall pattern.

Table 4. 4: People's perception towards rainfall in Mahadevtar, Kavre.

Change in Rainfall Volume			Change in timing		
Yes	No	Change in intensity only	No	Early	Delay
35	5	10	5	2	43

Source: Field Survey 2017

Table 4.4 reflects the people perceptions towards the rainfall pattern. Among the 50 respondents, 35 people (70%) said there has been change in the rainfall volume, 5 people (5%) said they do experienced any change in rainfall pattern and volume while 10 people (20%) said only rainfall intensities changed. Among the 45 people who experienced the change in rainfall pattern, they also experienced the timing of the rainfall. 2 people (4%) said the rainfall has shifted earlier while 43 people (46%) said the rainfall has delayed than earlier. This timing was consider especially for the monsoon rainfall.

There is also change in the monsoon timing in Nepal in the last decade. The normal onset date of monsoon in Nepal is 10 June and the withdraw date is 23 September. Table 4.6 shows the monsoon onset dates and withdraw dates in last 10 years in Nepal.

Table 4. 5: Monsoon onset and withdrawal date in Nepal

Year	Onset Date	Withdrawal date
2007	June 7	October 9
2008	June 10	October 17
2009	June 23	October 15
2010	June 17	October 1
2011	June 15	October 7
2012	June 16	September 28
2013	June 14	October 19
2014	June 20	October 7
2015	June 13	October 3
2016	June 15	October 15

Source: DHM 2017

Table 4.5 shows that there is change in timing of monsoon rainfall in Nepal. The normal monsoon onset date in Nepal is 10 June but in the last 10 years only a single day experienced the normal onset date, a single year's onset was earlier than the normal date and 8 years monsoon onset date was late. In an average, there is delay of about 5 days than the normal monsoon onset date in the last ten years. Similarly, the monsoon withdrawal date has also been shifted back than the normal date. The normal withdrawal date in September 23 but neither of the year experienced the withdrawal in that date of earlier than that. In average, there in a delay of 16 days in the withdrawal of monsoon in Nepal.

4.3.2 Perception towards Temperature Change

Temperature is one of the parameter of climate that greatly affects agriculture. Temperature as an effect on the life cycle of plants since the germination to the harvesting period. The study of temperature is very important for agriculture. The change in temperature pattern greatly affects the agricultural production.

There is no any climatic records from Mahadevtar village. The nearby climatic station is at Kavre district headquarter installed and regulated by Department of Hydrology and Meteorology, Government of Nepal. This studies focus on the local farmer's view towards climate change. Hence, the respondents were asked about the change of temperature

according towards their feelings. Table 4.7 shows the perception towards change in temperature by the respondents in last ten years in Mahavtar village.

Table 4. 6: Farmer's perception on temperature

Temperature	Yes	No	Do not know
Change	39	6	5
Increased	31	-	-
Decreased	8	-	-

Source: Field Survey 2017

From the response of the people we can say that the temperature has been changed in the last decade. Table 4.7 reflects that 78% of people felt the change in temperature pattern. Among 50 respondent, 6 people (12%) said there is no change in temperature while 5 people (10%) said they were unaware of temperature changes. 31 respondents (62%) said there is increase in the temperature in the last decade.

4.3.3 Perception towards the change of other climatic pattern

There are several others climatic factors other than temperature and precipitation which affects in the agriculture. Other factor that may influence in agriculture are fog, cloud, relative humidity, heat waves, cold waves, snow fall, hail etc. Table 4.8 reflects the people’s perceptions on the effect of these parameters in agriculture in Mahadevtar village.

Table 4. 7: Farmer's perceptions on change in different climatic parameters

S.N.	Climatic Parameters	No of Peoples					
		Change in pattern			Effect in Agriculture		
		Increased	Deceased	No idea	Positive	Negative	No idea
1	Clouds	22	19	9	30	11	9
2	Fog	30	16	4	16	30	4
3	Relative Humidity	14	9	27	28	6	16
4	Hail	18	22	10	21	29	0
5	Snow	Never Occurred					
6	Heat Waves	Never Occurred					
7	Cold Waves	Never Occurred					

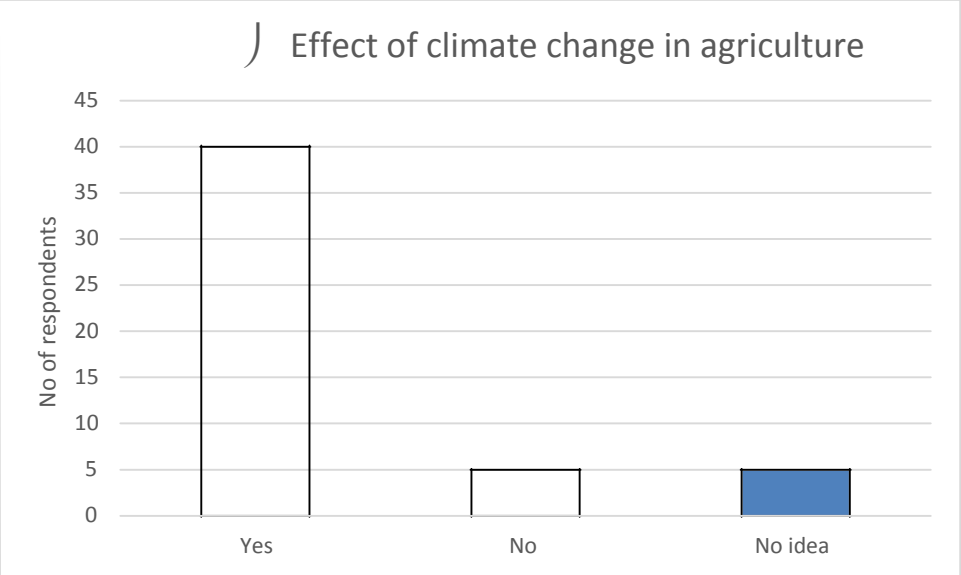
Source: Field Survey 2017

Table 4.7 shows that other climatic parameters has also been changed in the last decade in Mahadevtar village. Among the different climatic parameters, none of the respondents observed snow, heat waves and cold waves in Mahadevtar village. There was different views towards the changing pattern of cloud. Almost similar number said increased and decreased as well with a little percentage higher in the perception towards increased pattern and majority of them think increasing clouds amount signifies positively in agriculture. This could be because rainfall occur through clouds. Fog also changed its pattern in Mahadevtar. Majority of respondent (60%) felt that there is increased pattern of fog and that has negative impact in agriculture. Similarly, the increase percent of relative humidity has positive impact on agriculture. About 54% respondent feel that increase percent of relative humidity help in good agriculture production while 32% of them were unaware about the effect of relative humidity in agriculture. The respondent were also asked about the changing pattern of hail but no significant result can be get due to similar percentage of answer towards increased and decreased pattern but majority replied it has negative impact in agriculture.

4.3.4 Impact of Climate change in agriculture production

The respondents were asked differently on the effect of climate change in agriculture. The questionnaire was designed in such a ways that we get the answers of impact of climate change, crops that were affected by climate change and the cause of impact of agriculture i.e the particular climatic parameter which affects the specific crop. Fig 4.4 shows the people's perception on the effect of climate change in agriculture.

Fig 4. 2: Effect of climate change in agriculture



The impact of climate change is not same for all the crops. A type of change in climatic parameter may affect negatively for one type of crop while same change can have positive impact on other type of crop. Fig 4.4 and fig 4.6 show the impact of climate change in different types of crops that are cultivated in Mahadevtar village.

4.3.5 Change in Agriculture Production by Duration Wise

This research is also aims to get the effect of climate change in the temporal distribution. The local people was asked the effect of climate change in agriculture in three duration of time i.e. from 5 years to now, from 5 years to 10 years ago and beyond that. Table 4.9 reflects the duration wise effect of climate change in the major crops cultivated in Mahadevtar village.

Table 4. 8: Duration-wise change in production of different crops

S.N		Time Period	Change in Production			
			Increased	Decreased	No Change	No idea
1	Tomato	0 to 5 years ago	31	9	5	5
		5 to 10 years ago	14	22	9	5
		Above 10 years	2	4	34	5
2	Cauliflower	0 to 5 years ago	28	12	5	5
		5 to 10 years ago	7	28	10	5
		Above 10 years	5	30	10	5
3	Maize	0 to 5 years ago	11	27	7	5
		5 to 10 years ago	14	19	12	5
		Above 10 years	3	8	34	5
4	Rice	0 to 5 years ago	7	31	7	5
		5 to 10 years ago	17	19	9	5
		Above 10 years	3	8	34	5
5	Wheat	0 to 5 years ago	13	27	5	5
		5 to 10 years ago	19	21	5	5
		Above 10 years	11	2	32	5
6	Millet	0 to 5 years ago	10	30	5	5
		5 to 10 years ago	15	20	10	5
		Above 10 years	5	15	25	5
7	Cucumber	0 to 5 years ago	38	2	5	5
		5 to 10 years ago	10	20	15	5
		Above 10 years	16	19	10	5

Source: Field Survey 2017

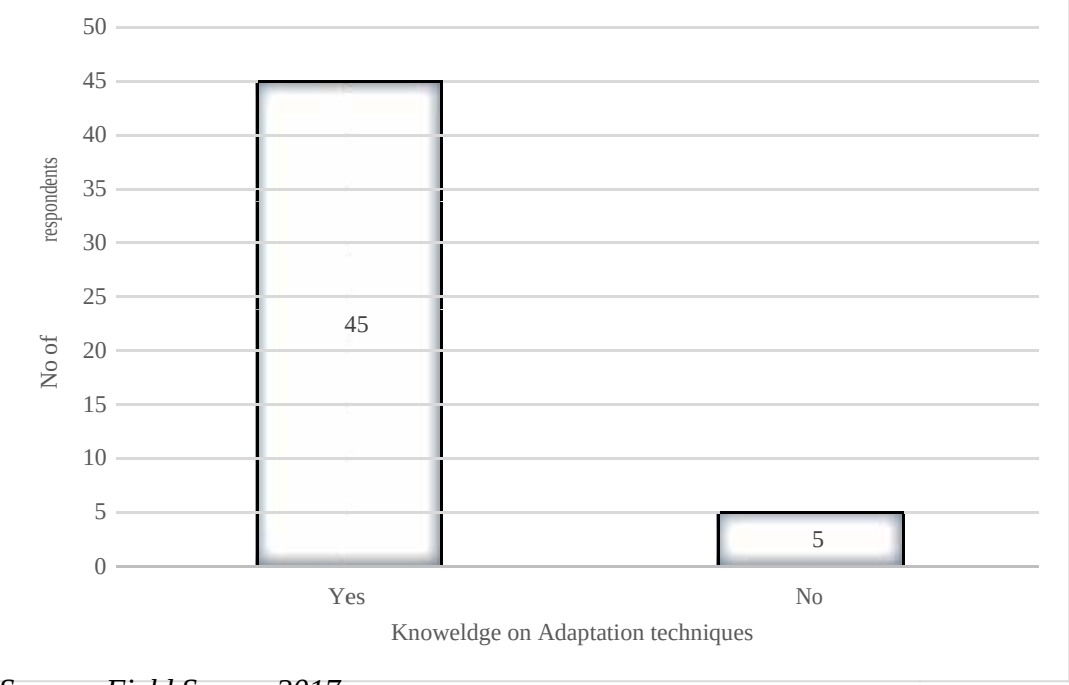
The table 4.8: reflects that the majority of crop production has increased in the last 5 years except wheat and millet. This may be due to use of fertilizers, hybrid seed and adopting climate change adaptation measures. The years between 5 to 10 years ago was

the years of worst production in crops in Mahadevtar village. That may be due to effect of climate change and farmers were not able to adopt the changing climate and the use of fertilizers and hybrid seed was not in practice. Still some of the farmers found increase in production in that period. That may be due to their good farming system, adaptation of climate change adaptation process and use of fertilizers and hybrid seen by them. Table 4.10 and fig 4.7 show the overall production of crops in Kavre that are cultivated in Mahadevtar village.

4.4 Adaptation Measures Taken in Agriculture

One of the measure objective of this research is to study the adaptation measures taken in agriculture in the rural areas of Nepal. The people of Mahadevtar also practiced in adaptation techniques against climate change. Fig 4.8 reflects the knowledge of adaptation techniques to climate change of the farmers of Mahadevtar village.

Fig 4. 3: Knowledge of adaptation techniques in farmers



Source: Field Survey 2017

Fig 4.3: shows that many of the respondents have general knowledge about the adaptations techniques to climate change. None of the respondent were unaware about the adaptation techniques towards changing climate in agriculture. Fig 4.9 shows the no of people who use the adaptation techniques to different crops.

4.4.1 Protection of Crops from Natural Disasters

The change of climate has introduced my natural disasters like flood, intense hailstorm, intense rainfall etc. Some of the climatic parameters may damage the crops in short duration even in less than an hour. Table 4.13 shows the preparedness towards natural disasters by the farmers of Mahadevtar in agriculture.

Table 4. 9: Protection of crops from natural disasters

S.N.	Crops	Protection from Natural Disasters	
		Yes	No
1	Rice	0	50
2	Maize	0	50
3	Wheat	0	50
4	Millet	0	50
5	Cauliflower	36	14
6	Tomato	37	13
7	Cucumber	25	25

Source: Field Survey 2017

Table 4.9 shows that there id protection from disasters only for some of the crops and mainly the cash crops. The protection for cauliflower, tomato and cucumber was common in Mahadevtar. There the protection building greenhouse for the entire life of tomato while protection for cauliflower and cucumber was only at the germination period and early period.

4.4.2 Use of Improved/New Seeds

The old type of crop or seeds may not have enough productivity in changing climate. So, use of new seeds is one of the best method to increase the productivity of the crops. Table 4.14 shows the number of farmers those uses new types of crops for different crops that are cultivated in Mahadevtar village.

Table 4. 10 Use of improved seeds for different crops

S.N.	Crops	Use of Improved/New Seeds	
		Yes	No
1	Rice	19	31
2	Maize	25	25
3	Wheat	5	45

4	Millet	0	50
5	Cauliflower	45	5
6	Tomato	45	5
7	Cucumber	25	25

Source: Field Survey 2017

Table 4.10 shows that the farmers are interested in improved seed and many farmers are using improved and new types of seed. There is less use of improved seeds in food crops while much more adaptation of new seed in cash crops. Though all farmers are not using improved seed in every crops but majority of them used improved seeds except for millet.

4.4.3 Change in Cropping Pattern

With the changing climatic patterns, the change is cropping pattern may be useful in the production of crops. Table 4.11 shows the number of respondents who change cropping pattern in anyway.

Table 4. 11: Change in cropping pattern

S.N	Crops	Change in Cropping Pattern	
		Yes	No
1	Rice	50	0
2	Maize	50	0
3	Wheat	50	0
4	Millet	50	0
5	Cauliflower	50	0
6	Tomato	50	0
7	Cucumber	50	0

Source: Field Survey 2017

Almost all the respondents are changing the cropping pattern. Even the farmers who think there is no climate change have also change the cropping pattern according to rainfall pattern in Mahadevtar village. Some of the farmers are cultivating cash crops more than food crops and minimizing the use of water by different irrigating practices and constructing greenhouse.

4.4.4 Consulting Agriculture Experts

There are different modern techniques that are used to cope with the climate change. Table 4.16 shows the respondents behavior towards consulting agriculture experts in Mahadevtar village.

Table 4. 12: Consulting agriculture experts

Do you consult agriculture experts?		Is it fruitful?	
Yes	No	Yes	No
45	5	45	0

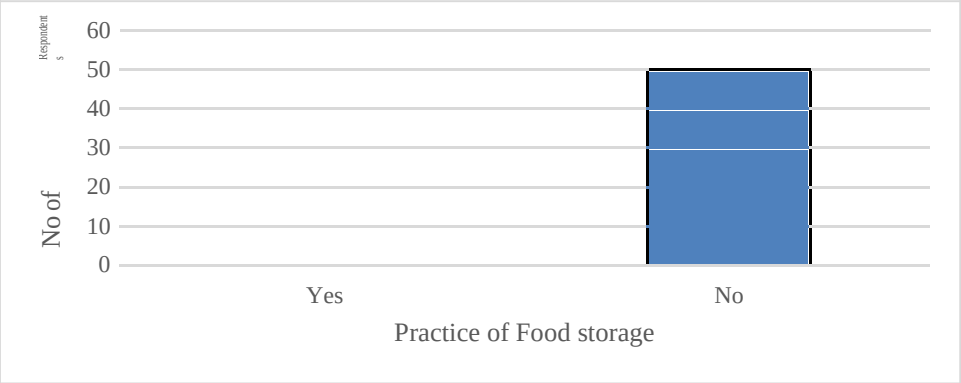
Source: Field Survey 2017

Among the 50 respondent, 45 farmers (90%) consult the agriculture experts and all of them find it fruitful.

4.4.5 Practice of Food Storage

Food storage system is one of the good techniques of adaptation. The farmers can store food in the high production year and use that food in low production. Fig 4.12 shows the number of farmers soring food in Mahadevtar village.

Fig 4. 4: Food storing practice



Source: Field Survey 2017

Fig 4.12 reflects that there is no food storage practices in Mahadevtar village. This is because none of the respondent produced more than enough food crops and they sell all the cash crops and there is no any mechanism to store cash groups in the village.

4.4.6 Different Supporting Organizations

There are different supporting organizations to improve the agriculture production and adopt with the climate change. Those organizations can be broadly listed as:

- Government sector (District Agriculture Development Office)|
- Different NGOs|
- Local Group|

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The main objectives of this research was to know the knowledge of rural people towards climate change, the effect of climate change in rural agriculture and explore the adaptation measures taken by rural farmers. Mahadevtar village is place in with different caste people which are common in the hilly area of the Nepal.

5.1 Profile of Respondent

The research was aimed to get as much as information from the field. Most of the respondent are above 30 years. All of the respondents are of the origin of the Mahadevtar VDC. Respondents consists of different eight caste people with the majority of Sherpa-the indigenous people of high mountains of Nepal. They have both irrigation and rain-feed farming systems in practices.

5.2 Farmers Knowledge on Climate Change

Through the filed survey, it is found that most of the people think they have knowledge of climate change. Among the 50 respondent, 46 farmers (92%) said they are aware of climate change and among the respondents 40 farmers (80%) feel that there is change in climate in the recent years, 6 farmers (12%) feel that there is no change in climate while 4 farmers (8%) were unaware about climate change. The farmers were asked about the different parameters of climate change. They also feel that different climatic parameters are changing.

Majority of farmers feel that there in change in rainfall pattern in Mahadevtar village. Many of the farmers find the delay in the rainfall timing. This delay in rainfall timing was considered for the monsoon rainfall. According to the record of DHM, rainfall measured in Kavre district headquarter, there if high fluctuations in annual rainfall pattern of last few decades with a slight increasing trends. There in an average delay of onset of rainfall in Nepal of about 5 days in last ten years and average delay of monsoon withdrawal of 16 days.

The farmers of Mahadevtar village also feel the change in temperature in the recent years with the increasing trend. Among the 50 respondents, 31 farmers (62%) feel that there is increase in temperature in Mahadevtar village. The data recorded from the field office ofKavre suggests that there is increase in average temperature and not significant high change in annual average rainfall but high annual fluctuations.

The agriculture is affected not only by the change in temperature and rainfall patterns but also by other climatic parameters like clouds, fog, relative humidity, hail, snow, heat waves, cold waves, wind, etc. Among them, none of the farmers found snow, heat waves and cold waves in Kavre. Among them, fog and hail has created negative effect most in the agriculture.

5.3 Impact of Climate in Agriculture Production

The research was focused in the impact of the major seven crops cultivated in Mahadevtar village. The major crops are tomato, cauliflower, maize, rice, wheat. Millet and cucumber. Most of the farmers find the effects of climate change in the production of these crops. 40 respondents (80%) said that there is effect of climate change in the production of crops, 5 respondents (10%) said there is no effect of climate change in agriculture of Mahadevtar VDC and 5 respondents (10%) said they have no idea about the effect of climate change in agriculture. The effect of climate change was not always same to all crops. The farmers finds that there is increase in the production of tomato, cauliflower, maize, rice and cucumber while decrease in the production of wheat and millet. The increase in production of those crops may be the favorable climatic conditions than in the past or use of fertilizers and improved seeds. The increase in the production was mostly found in the last five years.

5.4 Adaptation Measures Taken in Agriculture

There is high practices of adaptation measures to climate change in Kavre in with 45 respondents (90%) of the farmers are practicing any of the different adaptations techniques. There is practice of adaptation techniques more in the cash crops like cauliflower, tomato and cucumber and also in the food crops rice and maize. There is no practice of adaptations techniques for millet and some farmers only have practice of adaptation techniques in wheat. The climate change adaptations practices applied in Mahadevtar village are:

- Changing irrigation pattern|
- Use of artificial fertilizers|
- Use of insecticides and pesticides|
- Construction of green houses|
- Use of improved seeds|

Among the different parameters, artificial fertilizers, insecticides and pesticides are used in high proportion of farmers. They are building plastic pond to store water. Sprinkle irrigation system, drip irrigation system and pipe irrigation system are common in recent years. They are also constructing greenhouse for the cash crops like tomato, cucumber and cauliflower. Improves seeds are used by farmers almost for all crops except millet while there in high proportion of farmers using improve seeds are for cash crops.

5.5 Conclusions

There are certain outcomes of this research. The major outcomes in accordance with the objectives are listed below:

- Many of the farmers have knowledge of climate change.|
- Many of the farmers think there is impact of climate change in agriculture.|
- Majority of farmers have knowledge of different climatic pattern and they feel that many of the climatic parameters like temperature, rainfall, cloud, relative humidity, hail and fog has impact in the agriculture production of Mahadevtar village.|
- Change in every climatic parameters does not has guarantee in the negative impact in the agriculture production. Change in some of the climatic parameters has led to increase in the production of some crops.|
- Farmers of Mahadevtar village have a knowledge of climate change adaptations techniques in agriculture.|
- The major adaptations techniques practiced in Mahadevtar village are changing the irrigation pattern, construction of plastic ponds to store water, construction of greenhouses, use of fertilizers, insecticides and pesticides.|
- There is increase in the production of many crops like rice, maize, tomato, cucumber and cauliflower. This increase in production may be due to suitable climate in the recent years or by the use of climate change adaptations techniques in the recent years.|
- There is no enough production in food crops to store for coming years.There is no any storage mechanism for the cash crops like tomato, cucumber, cauliflower, etc. so farmers sell it all.|
- Farmers consults different agriculture experts and that has been fruitful for them.|
- Different organizations including government, NGOs and local group are helping to increase the production and adopt with the changing climate.|

5.4 Recommendations

One the basis of the findings and the suggestions given by the farmers, the study suggests following recommendations for different people and concerned authorities.

- Detail study of change is climatic parameters is need to know the exact impact on agriculture.|
- Research in cropping system is needed to prescribe the best crop in Mahadevtar village.|
- Proper irrigation system should be managed.|
- Farmers should be provided with better seeds.|

- Training on agriculture should be given and also on the adaptation techniques to climate change.|
|
- There is over use of artificial fertilizers, pesticides and insecticides. Farmers should be made aware about the harm of those chemicals and use of natural fertilizers should be encouraged.|
|
- People are not storing food so they should be encouraged to store food and cold stores should be opened for storage.|

No research is perfects in every aspects. There are various limitations in almost every research works. This research was confined within the Mahadevtar village and do not reflect the result to whole district. The research was focused in the social aspects of agriculture production. All the results are dependent on respondents' response. There are few recommendations drawn after this research:

- The study should be made along with the technical aspects in the subject of climate change.|
|
- The technical aspect in the increase and decrease of crops production should be studied.

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ANNEX

QUESTIONNAIRE

Climate Change and its Impact on Agriculture (A case Study of Mahadevtar VDC, Kavre, Nepal)

Eligibility of Sample: Household whose major occupation is agriculture and those whoare enrolled in organization to promote the agriculture of Mahadevtar VDC.

Type of Questionnaire: Close ended structured questionnaire and semi-structuredquestionnaire to retrieve quantitative and qualitative data.

Participant No.:	Interviewer Name:
Interview Date:	Signature:

GENERAL INFORMATION OF PARTICIPANT:

A. Name:	B: Ethnicity/Caste:
C. Age:	D. Sex:

OCCUPATION

Occupations	Tick	Occupations	Tick
Agriculture		Government Service (Agriculture Office)	
I/NGO (working in Agriculture Sector)		Government (Other than in Agriculture office)	
I/NGO (other than Agriculture Sector)		Other	

AGRICULTURE PRACTICE

1. Do you have land for agriculture production?

a. Yes b. No

2. What kind of farming system have you been practicing?

a. Rain fed b. Irrigation

c. Other.....

3. How much you produce?

Crops	Not Enough	Enough	Enough and selling
i.			
ii.			
iii.			
iv.			
v.			
vi.			
vii.			
viii.			

KNOWLEDGE OF FARMERS ON CLIMATE AND CLIMATE CHANGE

4. Do you know about climate change?

a. Yes b. No

5. Do you about climatic parameters?

Climatic Parameter	Tick	Climatic Parameter	Tick
Rainfall		Temperature	
Humidity		Visibility	
Wind/Strom		Evaporation	
Fog		Hail	
Cold wave		Hot wave	

6. In your knowledge, what is climate change?

SN	Climatic Parameter	Tick
i.	Change in temperature	
ii.	Increase in rainfall	
iii.	Decrease in rainfall	
iv.	Change in rainfall pattern	
v.	Warm in summer and cold in winter	
vi.	Rain in monsoon	
vii.	More hotter summer and more colder winter	
viii.	Heat waves	
ix.	Cold waves	

7. Have you noticed any changes in above parameters?

SN	Climatic Parameter	Yes	No
i.	Change in temperature		
ii.	Increase in rainfall		
iii.	Decrease in rainfall		
iv.	Change in rainfall pattern		
v.	Warm in summer and cold in winter		
vi.	Rain in monsoon		
vii.	More hotter summer and more colder winter		
viii.	Heat waves		
ix.	Cold waves		

8. Have you ever noticed any changes in your agriculture production due to climate change?

SN	Crops	Increased	Decreased	No Change
i.				
ii.				
iii.				
iv.				
v.				
vi.				
vii.				
viii.				

9. In your perception, what can be the possible reason for change in agriculture production?

SN	Crops	Reasons
i.		
ii.		
iii.		
iv.		
v.		
vi.		
vii.		
viii.		

10. How has the agricultural production in time series?

SN	Crops	Time Period	Increased	Decreased	No change	Don't know
i.		0 to 5 years				
		5 to 10 years				
		Above 10 years				
ii.		0 to 5 years				
		5 to 10 years				
		Above 10 years				
iii.		0 to 5 years				
		5 to 10 years				
		Above 10 years				
iv.		0 to 5 years				
		5 to 10 years				
		Above 10 years				
v.		0 to 5 years				
		5 to 10 years				
		Above 10 years				
vi.		0 to 5 years				
		5 to 10 years				
		Above 10 years				
vii.		0 to 5 years				
		5 to 10 years				
		Above 10 years				

11. What are the major problems raised in agriculture due to climate change?

i. Shortage of water

ii. Over rainfall

iii. High temperature

iv. Low temperature

v. Storm/hail

vi. Diseases

vii. Unwanted and new grasses and vegetation

viii. Other (mention).....

ADAPTATION TECHNIQUES

12. Are you aware of adaptation techniques to climate change?

a. Yes b. No

13. For which crop/s you are adapting other than traditional system?

i.....

ii.....

iii.....

iv.....

iv.....

v.....

vi.....

vii.....

14. Have you change the irrigating

pattern? a. Yes b. No

If Yes:

Type	Crops	Since

15. Are you using artificial fertilizers?

a. Yes b. No

If Yes:

Crops	Since

16. Are you using insecticides and pesticides?

a. Yes b. No

If Yes:

Crops	Since

17. Are you protecting your crops form natural disasters?

a. Yes b. No

If Yes:

Crops	Techniques	Since

18. Are you using improved seeds and

plants? a. Yes b. No

If yes:

Crops	Since

19. Are you changing cropping

pattern? a. Yes b. No

If yes:

Crops	Changed Pattern	Since

20. Do you practice food storage techniques?

a. Yes b. No

If yes:

Crops	Storage type

21. Do you consult to agriculture experts? a. Yes b.

No

If yes:

Has it been fruitful? a. Yes b. No

22. Do any individual or organization/s is/are supporting for adaptation for climate change?

a. Yes b. No

If yes:

i. Government organization

ii. Individual

iii Local Group/s

iv. NGO/s

v. Other:.....

Thank You