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Climate Change and its Impact on Agriculture of Gharapjhong Rural Municipality of Mustang District, Nepal

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Abstract:- Climate change is a proven and burning issue in this world. It has visibly impacted different nations. From this research on Gharapjhong Rural Municipality of Mustang district of country Nepal, it is again proved that the climate at the local level has been experiencing increasing trends of both precipitation and temperature as per the data from 1988 to 2017. The study was conducted to study the impact of climate change on agriculture of the Mountainous area of Nepal i.e. Gharapjhong Rural Municipality of Mustang District. Field observation, Questionnaire survey, Key Informant Interview, and Focus Group Discussion was carried out to obtain primary data whereas; secondary data were collected from the Department of Hydrology and Meteorology, Ministry of Agriculture and Livestock Development, Budget program for Gharapjhong Rural Municipality (2074/2075), authorized report and papers. Different trend analyses and correlations were plotted to validate the research objectives. The analysis of productivity trend (1999/00- 2016/17) was found to be increased in maize, potato, barley whereas decrement of trend in wheat and oilseed. Apple productivity data from the year 2012/13 to 2016/17 also shows linear increments. Both the agricultural data analysis part and local people's experience part show similar outcomes, i.e. positive as well as negative impact on agricultural production due to climate change. Analysis of sales of chemical fertilizers data (2013/14 to 2016/17) shows the increasing trend of chemical fertilizers. The majority of the respondents are practicing inter-cropping, planting new crops, increasing the use of biofertilizers and pesticides. Whereas, every respondent is using an irrigation system to cope with an increasing climatic trend.

Keywords:- *Climate change, Impact, Agriculture, Adaptation, Gharapjhong Rural Municipality.*

I. INTRODUCTION

Any significant long-term change in the expected patterns of average weather of a region (or the whole Earth) over a significant period is known as climate change (Mahato, 2014). Climate change is caused by an increase in certain greenhouse gases (GHG) such as carbon dioxide and methane in the atmosphere. It is considered to be one of the most serious concerns to sustainable development, with adverse impacts on the environment, agriculture, economic activity, natural resources, and physical infrastructures (ICAO, 2012). During the past few decades, the world has been experiencing a significant increase in global temperature resulting in climate change. Scientists are now confident that this rapid rate of increase in temperature is due to human-induced factors that are emission and accumulation of GHG in the earth's atmosphere. From 1906 to 2005 the global average surface temperature increased by 0.74 [0.56 to 0.92] °C. The linear warming trend over the 50 years from 1956 to 2005 was 0.13 [0.10 to 0.16] °C per decade is near twice that for the 100 years from 1906 to 2005 (IPCC 2007). In the context of Nepal, the global emission of GHGs is negligible per capita CO_2 emission of 0.13 tonnes. But, Nepal still faces the consequences of global warming because of the geographical and climatic conditions, high dependence on natural resources, and lack of resources to cope with the changing climate. Climate change and its impacts are gradually becoming a rising problem across the globe. According to Shrestha & Aryal (2011), Climate Change has been happening across the country with varying degrees of impact. Analyses of maximum temperature data from 49 stations in Nepal for the period 1971–94 reveal warming trends after 1977 ranging from 0.06° to 0.12°C yr−1 in most of the Middle Mountain and Himalayan regions, while the Siwalik and Terai (southern plains) regions show warming trends less than 0.03°C per year (Shrestha et al., 1999). Chaulagain, (2006) has pointed out that the climate in the Nepal Himalaya is changing faster than the global average. Nepal has good

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reasons to be concerned about CC over two million Nepalese people depend on climate-sensitive sectors like agriculture and forestry for their livelihood (Garg & Kapsh, 2007). Due to its location in the Himalayan belt, the Mustang district is one of the highly impacted districts in terms of climate change impacts. For example, average rainfall in Mustang almost doubled in 2051-62 (450ml) as compared to 2040-50 (250ml). A sudden temperature rise was also observed wherein 2040-50 the maximum temperature was 21-22 degree Celsius but currently, it is 25-26 degree Celsius (Adhikari, 2014). The impacts are very intense in a country like Nepal. The impact of climate change is sometimes positive also (Regmi & Adhikari, 2007). Pradhan, (2012) from Mustang district reported that the cultivation of the cabbage, cauliflower, tomato, chilly, mango, and other tropical species were possible now but about a decade ago it was not possible due to frost, snow, and intense cold erratic and intense but short duration of rainfall.

II. CLIMATIC VARIATION

The annual average precipitation from the year 1988 to 2017 of Mustang district shows monthly average precipitation increasing at the rate of 3.123 per annum. There was the lowest precipitation in 1992 with 429.575mm and the highest in 2013 with 709.225mm. A similar outcome was observed by Baidya et al. (2008) according to which, most of the stations of Nepal show an increasing trend of total annual precipitation. In the case of the driest year (Manandhar et al., 2011), too found the year 1992 (with high negatively normalized value) to be the driest in the last 30 years. While plotting the annual average seasonal precipitation datum, it was observed that the monthly average pre-monsoon precipitation was increasing at the rate of 0.449 per annum. There was the lowest pre-monsoon precipitation in 2011 with 57.350 mm and the highest in 2006 with 202.450 mm. Monsoon precipitation was also increasing at the rate of 0.306 per annum. The lowest monsoon precipitation was in 1997 with 263.420 mm and the highest monsoon precipitation was in 2010 with 481.470 mm. For the post-monsoon precipitation trend, it was observed that the precipitation trend was decreasing at the rate of 0.113 per annum. There was maximum post-monsoon precipitation in 1996 with 100.925 mm and minimum precipitation was in 1994 with 5.600 mm. For the winter precipitation trend, it was observed that the winter precipitation trend was increasing at the rate of 0.088 mm per annum. There was maximum winter precipitation in 1997 with 171.167 mm and minimum in 2016 with 14.125 mm. The average monthly rainfall of the Gharapjhong Rural Municipality of the 30 years data from 1988 to 2017 shows that July was the wettest month i.e., the average monthly rainfall of July months was 889.350mm. November month was the driest month and receives a very low amount of rainfall i.e. 47.050mm. Ichiyanagi et al. (2007) also, found that winter rainfall over western Nepal has increased. The mean monthly rainfall for the month July was found highest and the month November receives less rainfall. A similar study was done by Joshi et al. (2011) at Doti showed July as the wettest month and November as the driest month. When the monthly rainfall averaged over decades, then the result showed that precipitation has been increasing from past years to recent. A similar observation was carried out by Shrestha et al. (2000), according to this report, the precipitation data from Nepal over the past three decades show large decadal variability in the all-Nepal as well as regional (within Nepal) precipitation records From the analysis of rainfall data, the maximum percentage of total rainfall occurred in the monsoon season. Thirty years of data from 1988 to 2017 on rainfall shows that the monsoon season (June-September) contributes 61 percent of the total annual rainfall. Similarly, pre-monsoon (March-May), post-monsoon (October-November) and winter monsoon (December-February) seasons account for 24 percent, 5 percent, and 10 percent respectively. The analysis was done by PAN (2009) also shows that the maximum rainfall (about 80 %) occurred during the monsoon season in Nepal.

To study the decadal rainfall change, rainfall data from the year 1988 to 2017 were divided into three equal parts, i.e., 1988-1997, 1998-2007, and 2008-2017. When the monthly rainfall averaged over decades, then the result shows that monsoon rainfall has increased i.e. total rainfall of 1292.400 mm in 1988-1997, 1569.300 mm in 1998-2007, and 1627 mm in 2008-2017, which was high enough to cause high moisture in the study area. During the period from 1988 to 1997, maximum rainfall used to occur during the august season now the study shows that the high peak point of rainfall has shifted to July season i.e., one month earlier than before (Figure 1).

There was an increasing trend in annual average maximum temperature, minimum temperature, and mean temperature with 0.049°C per year, 0.005°C per year, and 0.027°C per year respectively. The seasonal trend of the average temperature on all season i.e., Pre-monsoon, monsoon, post-monsoon, and winter monsoon also showed an increasing trend with 0.019°C, 0.002°C, 0.029°C, and 0.068°C per year respectively. Chaulagain (2006) also found temperature change to be more pronounced at higher altitudes than at lower altitudes. According to Manandhar et al. (2011), average annual maximum temperature data over 30 years (1997 to 2007) have revealed a significant rise in temperature in the Marpha of Mustang district. The monthly maximum, mean and minimum temperature reaches highest at the peak in July and lowest temperature in January. The national-level data prepared by PAN (2009) also show that except Mid-western development region almost all regions of the country showed an increasing trend, but, some small pocket areas showed decreasing trend i.e. areas around Dhankuta, Dolakha, Ramechhap, and Tanahu Districts.

For the decadal temperature change, maximum and minimum temperature data from the year 1988 to 2017 were divided into three equal parts, i.e., 1988-1997, 1998-2007, and 2008-2017. When the monthly maximum temperature was averaged over decades, then the graph shows the increment of temperature in each month in the recent decade (2008-2017). There was a high increment of temperature in the winter season when compared with other months (very low increment) as shown in figure 2. Similarly, when the

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monthly minimum temperature was averaged over decades, then the graph shows fluctuation i.e. increment, decrement, and same temperature in other months but the remarkable increment in the winter season of a recent decade (2008-2017) (Figure 3). IPCC (2013), also found that the temperature of both the winter and summer seasons has been in increasing trend.

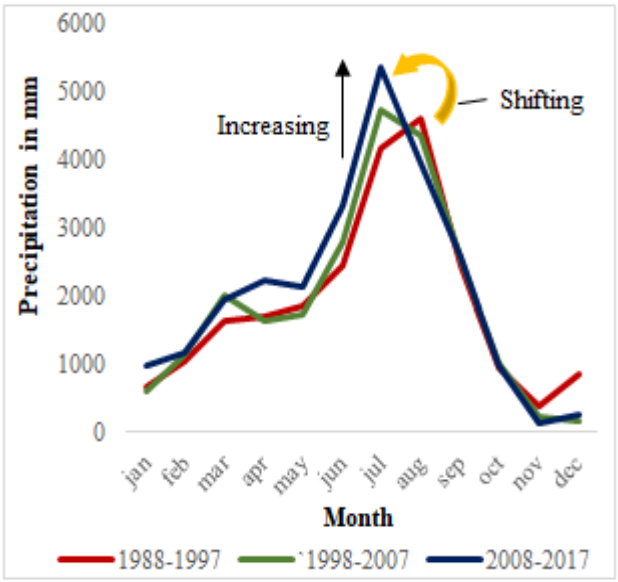

Figure 1: Average monthly decadal rainfall from 1988 to 2017

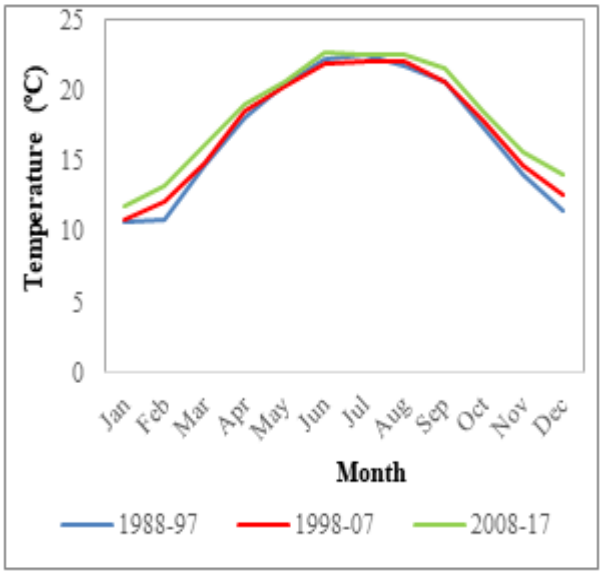

Figure 2: Average monthly decadal maximum temperature

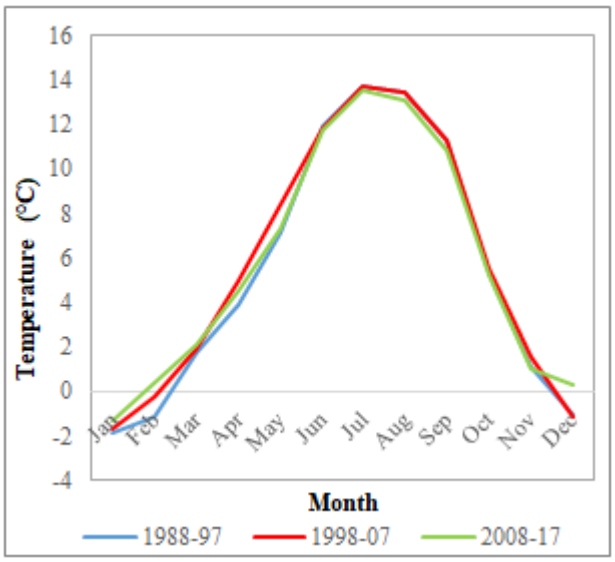

Figure 3: Average monthly decadal minimum temperature

Same responses were collected from local people before that assurance was needed for whether they were aware of climate change or not. When they were asked about the matter, 94% of respondents replied that they were aware of climate change through different formal and informal mediums, some of them have also attended climate change-related training and workshops and the rest of them that is 8% were still unknown about climate change. The majority of respondents i.e. 84% responded that precipitation is increasing while 82% responded that temperature is increasing. This validates that there was an actual increase in precipitation and temperature in the study area.

III. RELATION BETWEEN CROP YIELDS WITH RAINFALL AND TEMPERATURE

The trend of climatic data from the year 1999/00 to 2016/17 was found to be increasing. For rainfall, it was increasing by 4.116mm annually similarly, for maximum temperature and the minimum temperature it was increasing with 0.092°C and 0.003°C per year respectively. The statistical observations on productivity with precipitation and temperature trend for the same year show both positive as well as the inverse relationship between productivity and climatic trend. That means an increase in temperature and rainfall have a positive impact on most of the production of the crops like maize, barley, and potato (4.099, 29.275, and 243.750 kg/ha/year respectively) whereas inverse relationship with oilseed and wheat yield (-3.712 and -10.652 kg/ha/year respectively). Bivariate correlation between crop's yield and climate shows that there was an insignificant correlation between them except in the condition of potato i.e. correlation was significant between potato yield and maximum temperature with the value of 0.503 at 0.05 level (2-tailed) as shown in table number 2. Weather is an atmospheric condition at the surface timescale from minutes to weeks and has an important impact on agriculture (ICIMOD/ UNEP, 2007). Manandhar et al., (2011) too found that the effects of climatic change are

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unevenly distributed. Research has provided evidence that upland farmers have to some extent benefit from the changes, while lowland farmers lose out most of the time. Moreover, they also found that Cold waves, on the other hand, affect the winter crops. Most farmers have, therefore, stopped planting mustard and lentil, and only a few of them still grow these crops on a limited scale. According to Shrestha & Aryal (2011), temperature increase has mixed effect in the case of wheat as the actual yield of wheat has increased in the western region with the rise of temperature and declined in other regions whereas, Temperature increase has harmed maize yield. In the case of production of apple, there was no productivity data of apple before the year 2012/13 however, analysis of apple production data can't be neglected since apple is the most important crop species in the study area both by economically and indigenous specialty purposes. Apple productivity data from the year 2012/13 to 2016/17 shows a linear increment of apple yield with 250 kg/ha/year whereas, climatic data for the same year shows the negative trend for both precipitation (-29.923mm per year) and temperature (maximum temperature with -0.065°C and minimum temperature with -0.448°C per year). Bivariate correlation between apple yield and all climatic terms shows the negative correlation between them. Manandhar et al., (2011) also found that the production of apples has expanded in the higher altitudes. Among 68 households, 94% of respondents were aware of CC. The majority of the respondents responded that precipitation (84%) and temperature (82%) were increasing which validate the actual data analysis. According to local people and different published and unpublished data, there was excessive snowfall in the October season of 2014 (Oz et al., 2016). People of the study area told that excessive snowfall that year causes huge destruction of different crops, which can be seen in different graphs produced below. From the analysis of the graph below, almost every crop was affected by huge snowfall that year but among them, a yield of maize, apple, and potato was excessively infected by declining their huge yield of 305kg/ha, 500kg/ha, and 3,657kg/ha respectively when compared to previous year data. The positive impact of climate change on agricultural production might be due to different factors like use of the hybrid seed, use of fertilizer, use of pesticides and insecticides, etc. and other important factors may be due to increment in the duration of precipitation which creates moisture in soil and increment in surrounding temperature may have created the favorable environment to grow crops properly. This shows that there is a direct relationship between climate change and crop yield. Whereas the negative impact of climate change to some crop types like oilseed and wheat yield may be due to increment of new pest species, increment of different crop diseases, etc. and other factors may be because of shifting these crops by other, mobility of youth in abroad to earn money and many other social factors.

IV. PEOPLE'S PERCEPTION ABOUT CLIMATE CHANGE AND AGRICULTURAL PRODUCTION

From the five wards of Gharapjhong Rural Municipality, 68 household surveys were carried out. The highest number of respondents i.e., 27% were from ward no. 5 (Thini) and the lowest number of respondents i.e., 13 % were from ward no. 1 i.e., Chairo. During the field survey, it was found that 68 % were male respondents, and the remaining 32% were female respondents. The age distribution of the respondents ranges from 24 to 80 years. The survey was targeted at middle-aged people. Out of total respondents, majorities were from the age group of 30-59 years occupying 55%.

The ethnic group of the survey area was Brahmin/Chettri, Janjati, and Dalit. The dominant group was Janjati consisting of 68% whereas the least group was Brahmin/Chettri consisting of only 1%. Among the interviewed respondents, most of the respondents were dependent on agriculture only. In total, 82% of respondents were dependent only on agriculture. Rests of the respondents were involving in business, government service, and other occupations. Out of the total respondents, 25% of them were illiterate. The majority of respondents i.e., 37% have attended below secondary level classes whereas only 3% of respondents were highly educated to graduation and above level. The average family size was found to be 4.66 which was higher than the national average family size i.e., 4.38 (CBS, 2011). The family size ranges from 1 to 11 members.

Among 68 respondents, 94% of respondents were known or aware of climate change. Very few, that is only 6% percentage of respondents were still unknown about climate change. Respondents have their own feeling about temperature and precipitation. The majority of the respondents, that is, 84% of total respondents have realized that the rate of precipitation is increasing, 7% of respondents replied the precipitation is decreasing, 6% percentage replied that there was no change whereas 3% of respondents were still unknown. While talking about the temperature change, the majority of the respondents, that is, 82% of total respondents have realized that temperature is increasing, 6% of respondents replied the temperature is decreasing, 10% percentage replied that there is no change whereas 2% of respondents were still unknown. The majority of the respondents said that the temperature has increased than the previous years. According to the respondents, 32 % said that winter temperature has increased, 12 % said that winter temperature has decreased, 9 % said that winter temperature has not changed, 37 % said that summer temperature has increased, 1 % said that summer temperature has decreased and 9% said that summer temperature has not changed. The majority of the respondents i.e. 37% said that there has been an increase in the temperature almost all the year. Further, they also said that the increase in the temperature has created the problem of the mosquito.). This shows the warming of the climate in the study area.

Discussions with people of the study area revealed that they have seen less snowfall in recent years. According to them, they used to have heavy snowfall 5-6 times during the winter but currently, the occurrence of such snowfall has decreased to only once or twice a year. When respondents were asked about the occurrence of snowfall, a very high percentage of respondents i.e. 75 % replied that there has been a decrease of snowfall occurrence, 16 % replied the same occurrence of snowfall, 6 % replied that they do not know about the snowfall occurrence whereas, very few percentages i.e. only 3 % replied that there has been an increase of snowfall occurrence. These unusual patterns have directly affected production in the agricultural sector of the study area, mainly to apple production, since apple trees need the chill temperature to grow properly. When respondents were asked about the name of crops that are mostly affected by decreased snowfall pattern, then they replied 52 % to apple, 33 % to wheat, 10 % to barley, 3 % to maize, 1 % to green vegetables, and 1% to potato. While talking about the change in hailstorm pattern, the majority of the respondents i.e. 68% of them has experienced an increase in hailstorm pattern, 18% of respondents replied same hailstorm pattern, 10% replied that they do not know about the changes and only 3% of them have realized a decrease in hailstorm pattern. According to them, an increase in hailstorm patterns is directly affecting the crops species during their flowering and fruiting period by detaching them from the plant's body or by causing different diseases. When respondents were asked about the name of crops that are mostly affected by a hailstorm, then they replied 41 % to potato, 25 % to apple, 11 % to wheat, 9 % to barley, 8% to maize, and 6 % to green vegetables. In the study area, respondents have realized negative impacts due to the increase in temperature and rainfall which has created a favorable environment to increase the number of the new pest.). Arnell (1999) explained that a temperature rise can lead to a general reduction in the proportion of precipitation falling as snow, and a consequent reduction in many areas in the duration of snow cover. Dey and Kumar (1983) found an inverse relationship (negative correlation) between Indian Summer Monsoon (ISM) rainfall and the extent of snow cover in the Himalayas, which suggests that there might be a link between increasing rainfall and decreasing snowfall in the Mustang region. The changing climate, however, has gradually created more favorable conditions for the diversification of agriculture. Crop diversification as a potential farm-level response to climatic variability and change has been explained by Bradshaw et al. (2004).

Many respondents shared their experience about the increasing number of pests in the study area. 67 % of respondents replied that they have observed increment of pest species number, 19 % replied that there is the same condition of pest, 11% replied that pest is decreasing, whereas, only 3 % replied that they don't know about the pest. When respondents were asked about the name of crops that are mostly affected by the pest, they replied 38 % to apple, 21 % to green vegetables, 18 % to wheat, 12 % to potato, 7 % to barley, and 4% to maize. Howden et al. (2007) too, suggested that pest, disease, and weed problems due to projected climate changes should be dealt with more sustainably using integrated pest and pathogen management as well as by adopting pest and disease-resistant varieties. Manandhar et.al. (2011) also has found the cultivation of vegetables such as cucumber, bean, tomato, pumpkin, and chili, both in the open and in greenhouses, has recently expanded into the upper regions of lower Mustang also the increasing number of rainy and foggy days has proven unfavorable for apple production in Kunjo, lower Mustang, as under the more humid conditions apple trees were infested by insects, pests and diseases, and eventually died.

As discussed above, agricultural data analysis has shown an increment of production in the majority of crop species (maize, barley, potato, and apple) while few crop species (oilseed, and wheat) are lowering their productivity. According to respondents, 68% among total respondents were experiencing increment in hailstorm pattern whereas, 75% among total respondents were experiencing decrement in snowfall pattern. They added increase in hailstorm excessively have created a problem for them both in their normal life and agricultural life. Large and intense hailstorms have contributed to detach the flowers and fruits from their plant body and also by causing different diseases to crops. When respondents were asked about the type of crop that is mostly affected by unusual hailstorm pattern then the maximum percentage of respondents i.e. 41% were answering to the potato plant followed by 25 % to apple, 11 % to wheat, 9 % to barley, 8% to maize and 6 % to green vegetables. Whereas, reduced snowfall—the main source of water supply—has contributed to water shortages which in turn harm agriculture production more on apple farming because the majority of respondents i.e. 52 % of them pointed to apple, 33 % to wheat, 10 % to barley, 3 % to maize, 1 % to green vegetables and 1% to potato.

In the study area, respondents have realized negative impacts due to the increment of the number of pest species. The majority of respondents i.e. 67 % of respondents replied that they have observed increment of pest species. People have realized its negative impacts, mainly on apple farming; the increase in rainfall and moisture in the air has been causing diseases in apples. They added apples have not been getting the type of texture and color in the skin that was seen in the past. While asking about the agricultural productivity of the respondents they replied that the agricultural productivity is decreasing than in recent years because of different diseases, pests, etc. However, they have also realized the positive impacts of climate change because high temperatures and precipitation have created a favorable environment to grow unusual and important crops like chilly, cucumber, tomato, etc.

Both the agricultural data analysis part and local people's experience part show similar outcomes i.e. positive as well as negative impact on agricultural production due to climate change. The reliability of the data sets used in this research for correlating the productivity and climatic data is low but not least. There might be further opportunities to research this matter with the most reliable data sets generated from other sources of records.

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V. LOCAL ADAPTATION MEASURES IN THE STUDY AREA

Chemical fertilizer is an important input for agriculture production. Nepal does not produce any fertilizers, so it has to depend on imports from India and third countries (Shrestha 2010). The sales of chemical fertilizers in the Mustang district for four years (2013/14 to 2016/17) shows an increasing trend of sales of all chemical fertilizer i.e. Urea, Di-Ammonium Phosphate (DAP), and Potash with 2.6, 0.9, and 0.3 Metric ton (Mt) per year respectively. Crop yield trend for the same period was 2.9, -142, -62.9, -20.7, 1168.9, and 300 for maize, wheat, barley, oilseed, potato, and apple with kg/ha per year respectively. From the analysis of the graph between sales of chemical fertilizer and crop yield, there was a mixed relationship between chemical fertilizer and crop yield (apple, maize, and potato) whereas, an inverse relationship between chemical fertilizer and crop yield (barley, oilseed, and wheat). Moreover, the correlation was significant between potato yield and sales of potash with 0.999 at the 0.01 level (2-tailed). Shrestha (2010) in his paper, also revealed that with the growing popularity of modern agriculture, fertilizer consumption in Nepal has been increasing over the years.

As an adaptive practice to the changing climate, farmers in Gharapjhong Rural Municipality are now increasingly turning towards the production of green vegetables, potato, tomato, chilly, and cucumber in the open or inside a greenhouse. To cope with the shortage of water in agriculture, the practice of using irrigation water is growing. In every 5 wards, there was the use of irrigation systems for growing their crops. The majority of the respondents have already practicing intercropping, planting new crops, tunnel use, increasing use of biofertilizers and pesticides Whereas, 100% of the respondents were using irrigation systems (Table 1). The statement by Manandhar et al. (2010) explained that farmers have made changes in their cropping calendar and cropping sequences to cope with changing climatic patterns.

Table 1: Local adaptation measures in the study area

S.N	Adaptation Measures	Users	Non- users	Total
1	Intercropping	78%	22%	100%
2	Changing of planting time	46%	54%	100%
3	Planting new crop species and verities	86%	14%	100%
4	Using hybrid seeds	76%	24%	100%
5	Using bio- fertilizers	74%	26%	100%
6	Using chemical fertilizers	13%	87%	100%
7	Using pesticides	86%	14%	100%
8	Tunnel (green house)	35%	65%	100%
9	Irrigation	100%	0%	100%

VI. CONCLUSION

The study suggests that- Annual precipitation and annual mean temperature trends were increasing by 3.123 mm and 0.027 ºC per year respectively. When the monthly rainfall averaged over decades were divided into three equal parts, i.e., from the year 1988-2017 to the years 1988-1997, 1998-2007, and 2008-2017 respectively, then the result shows that monsoon rainfall has increased which was high enough to cause high moisture in the study area. During the period from 1988 to 2007, maximum rainfall used to occur during the august season now the study shows that the high peak point of rainfall has shifted to July season i.e., one month earlier than before. Similarly, when the monthly maximum and minimum temperature were averaged over decades i.e. 1988-1997, 1998-2007, and 2008-2017, then the result shows that winter temperature has increased remarkably when compared with other seasons during the recent decade i.e. 2008-2017.

Analysis of agricultural data and meteorological data from the year 1999/00 to 2016/17 shows that the annual yield of the crops like maize, barley, and potato were increasing by 4.099, 29.275, and 243.750 kg/ha/year but crops like oilseed and wheat yield were decreasing by -3.712 and -10.625 kg/ha/year respectively. Whereas, both trends of average temperature and precipitation were annually increasing by the trend of 0.048ºC and 4.116mm per year respectively. This signifies that there was a positive impact of CC on maize, barley, and potato crops while the negative impact on oilseed and wheat. In the case of apple production, there was no productivity data of apple before the year 2012/13 however, analysis of apple production data can't be neglected since apple is the most important crop species in the study area both for economically and indigenous specialty purposes. Apple productivity data from the year 2012/13 to 2016/17 shows a linear increment of apple yield with 250 kg/ha/year whereas, climatic data for the same year shows the negative trend for both precipitation and temperature. Both the agricultural data analysis part and local people's experience part show similar outcomes i.e. positive as well as negative impact on agricultural production due to climate change.

The response adapted by the local people is an indigenous type rather than high technology and cost involving. To cope with changing climatic pattern, local people has increased its use of chemical fertilizer in the farmland to raise production of crops. Trends of sales of different fertilizers like urea, DAP, and potash are increasing with 2.6, 0.9, and 0.3 Mt per year respectively. The majority of the respondents have already practicing intercropping, planting new crops, increasing the use of biofertilizers and

pesticides. Whereas, every respondent was using an irrigation system to cope with an increasing climatic trend.

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