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Farmer's Perception and Responses to Climate Change and their Adaptive Mechanism in Kailali, Nepal

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Abstract: Climate change is a burning issue and a threat to ensuringfood security in the developing world, including Nepal. The study investigates about climate change and its adaptative measures from farmer's level. Bardgoriya, Janaki, and Kailari Rural Municipalities of Kailali district were purposively selected for the study. Farm households (180), 60 from each Rural Municipality were selected randomly to obtain the required primary information. The primary data were collected through a household survey and focus group discussion (FGD). The pre-tested semi-structured interview schedule and check-list were used to obtain the information. Most of the farmers perceived climate change as rise in temperature (91.7%), anddecrease in monsoon rainfall (96.1%) and decrease in winter rainfall (87.2%). The majority of farmers opined rainfall frequency decrease (92.2%), erratic rainfall pattern increase (80.6%), and delay in monsoon onset (81.7%). Most of the respondents opined increase in drought frequency (80%) and windstorm occurrence (56.1%), while flood frequency and hailstone occurrence perceived decreasing by 58.9% and 66.1% respectively. Due to climate change farmers' have been facing increased weed invasion (86.7%),crop water demand (98.3%) and cost of production (83.3%),and decreased soil moisture (84.4%).As a climate change adaptation measure, about 76% of the total respondent households have shifted the planting and harvesting time, 60.6% focused on irrigation management, 60.6% followed mulching practices, 53.3% increased use of chemicals (fertilizers, insecticides, and pesticides), and 51.5% changed the crop varieties. The study concludes that, farmers are facing climate change and its adverse impact to the farming, so appropriate climate change adaptation techniques have to be considered in the farming systems.

Keywords: Adaptation, climate change, perception.

INTRODUCTION

The contribution of agriculture sector to national gross domestic product (GDP) in the fiscal year (FY) 2018/19 was 27.5% (MOF, 2020). Nepalese farming system is prevalence with weather dependence, rain-fed and timely unavailability of the agricultural inputs, which cause slow growth of the agriculture sector (Aryal, Giri, Basnet, & Kandel, 2018). In the developing countries, majority of people living in village are poor and mainly depend on subsistence farming, who are economically weak and technologically back to cope with the adverse impacts of climate change (Seaman, *et al.*, 2014).Thus, in developing nations where population mainly depends on agriculture, the climate change effect is projected more serious (Seaman, *et al.*, 2014).The rain-fed farming systems are highly affected by climate change, therefore most of the farm households in Nepal are climate vulnerable (Pradhanang, *et al.*, 2015). Nepal is ranked as 20th position in the Global Climate Risk Index and identified as 9th country among most affected from climate hazards during the period of 1999 to 2018 (Eckstein, *et al.*, 2019).

MoFE, (2019) studied change in precipitation and temperature of Kailali district which projected both temperature and precipitation in medium term (2016-2045) and long term (2036-2065) will be increased. MoFE, (2019) reported cold spell duration index, cold nights, cold days will be decreased in medium- and long-term period but extreme wet days, warm days, warm nights, warm spell duration index will be increased in Kailali district.Rising temperature and erratic rainfall affects the cropping pattern and decreases agricultural productivity (Dhakal, *et al.*, 2013), and high dependency of Nepalese agriculture on rainfall make rural households' food security sensitive to climate change (Guo, 2016).

Tiwari, *et al.*, (2010) recorded people perception on climate change from different regions of Nepal and found that people from Himalaya to Terai were experiencing climate change with increasing temperature. Tiwari and Bauer, (2015) found that farmers from tropical region of Nepal perceived climate change as change in temperature and rainfall pattern. The study found that all the farmers from study area reported that the pattern of rainfall was changed and they were facing long drought, erratic rainfall, decreased amount and frequency of annual rainfall, decreased winter rainfall, increased in hailstones and frosts and unpredicted monsoon rainfall.

Adaptation is the process of minimizing the actual or expected impact of climate change through some adjustment measures and modifications (Grist, 2015). Pant, (2012) stated that developing countries like Nepal are practicing adaptation measures to climate change more than mitigation measures. While both adaptation and mitigation

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measures should be applied effectively because alone one cannot avoid risk of climate change and its impact (IPCC, 2007a). Maharjan and Maharjan, (2017) stated that in coming days climate change will be worse than the present scenario, hence its mitigation and adaptation measures should be practiced at local, national and global level. Government of Nepal has issued some policies regarding climate change as National Adaptation Programme of Actions (NAPA) in 2010, Climate change policy in 2011 and Local Adaptation Plan of Actions (LAPA) in 2011, which are interconnected to each other and helps to implement adaptation practices at local level (Maharjan& Maharjan, 2017). Agriculture Development Strategy (ADS) emphasized on practicing climate smart agriculture to minimize farmers' vulnerability to climate change (Thakur, 2017).

Farmers are coping and practicing adaptation measures against climate change (Hussain, Rasul, Mahapatra, &Tuladhar, 2016) according to their indigenous knowledge, skills, and experience (Tiwari, *et al.,* 2010; Maharjan, *et al.,* 2011). Whereas, Regmi and Bhandari (2012) revealed that impact of climate change is beyond adaptation measures followed by local people according to their indigenous knowledge as the severity of impact is increasing and people coping capacity became fragile.ICIMOD (2009) stated that the adaptation at local level is more important which is directly connected with household need and development.In Nepal, there is need of intensive study of climate change and factor affecting adaptation for effective implementation of adaptation and mitigation practices (Maharjan & Maharjan, 2017). However, there are limited studies which include climate change perceptions of farmers from Kailali district (Maharjan, *et al.,* 2011; Thapa, *et al.,* 2015; Chaulagain & Rimal, 2019). Since in Sudurpashchim Province monsoon starts lately and winter rainfall is more than other regions, it is important to record local people perceptionon climate change and adaptation measures followed by them.

METHODOLOGY

Study Area

The study was conducted in Kailali district (Western Terai) of Nepal. In Kailali district there are thirteen local bodies as one Sub-Metropolitan City, six Municipalities and six Rural Municipalities. Bardgoriya Rural Municipality (population: 32,683 and area: 77.3 km^2), Janaki Rural Municipality (population: 48,540 and area: 107 km^2) and Kailari Rural Municipality (population 47,987 and area 233 km^2) of the Kailali district were selected as research sites. The adaptive capacity of Kailali district is moderate (i.e. 0.286) and the selected research sites have high vulnerability ranking of 2.5 to 3.25 (JVS, 2017). In Kailali, average maximum temperature and minimum temperature in the autumn are 43°C and 24°C respectively, and in the winter are 19°C and 5°C respectively (DDC, 2015). The average annual rainfall is 1,840 mm in Kailali district (DDC, 2015). Most part of the district is covered by forest land which is 64.8% of total area and 27.8% area is fertile cultivated land (DDC, 2015).

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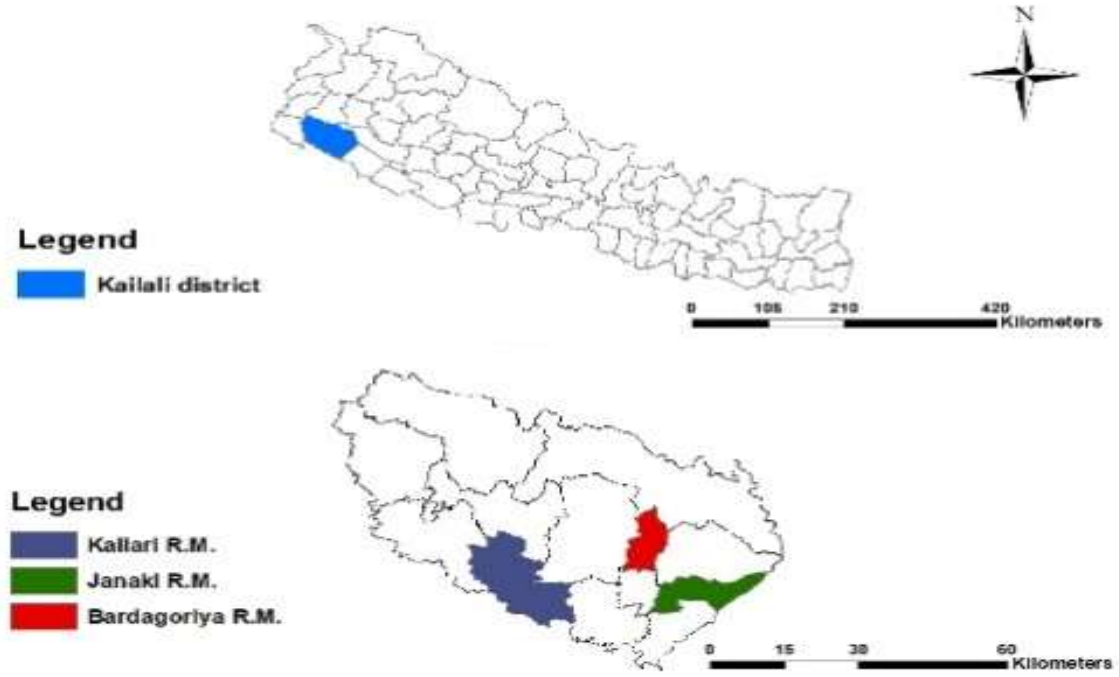

Figure 1: Map of Nepal showing Kailali district andmap of Kailalishowing study areas
Source: MOLCPA (http://www.dos.gov.np)

Preliminary Survey
For the preparation of questionnaire and designing of a sampling frame various information on demographic and socio-cultural distribution of the study site were collected by pre-survey field visit.

Sampling and Sample Size
All of the farm households in Kailali district were the population of the study. Sampling frame was the list of farm households of the selected rural municipalities. For the household survey, 180 farm households, 60 from each rural municipality were interviewed with the help of pre-tested semi-structured interview schedule. A sample size of 60 is generally regarded as the minimum requirement for larger population that yields a sufficient level of certainty for decision-making (Poate & Daplyn, 1993). All the respondents were sampling unit. For avoiding biasness simple random sampling was applied to select the respondents.

Methods of Data Collection
Methodological triangulation was employed to obtain data from different sources such as Observations, Interviews, and Focus Group Discussion (FGD) helped to harness diverse ideas about the same issue and assisted in triangulation of the results, and consequently to increase the validity and reliability of the findings (Rialp & Rialp, 2006; Bryman, 2008). Both the primary and secondary data were collected and analyzed.

Sources of Information
For the study, household head of selected household were considered as a primary source of information, and in case of unavailability of household head, data were collected from the member who involves in the decision- making of farming activities. Focus group discussion (FGD) and key informant interview (KII) were also conducted to obtain the primary data.

Secondary information was collected from the Central Bureau of Statistics (CBS), Agriculture Knowledge Centre (AKC), Ministry of Agriculture and Livestock Development (MOALD), rural municipalities, and from the various published materials like journals, research articles, bulletins, books, proceedings of various NGOs and INGOs, reports of National Agriculture Research Council (NARC).

Interview Schedule
Interview schedule was prepared to collect primary information from farm households. Both closed and open-ended questions were established during the interview schedule design. After the finalization of the interview schedule, data were collected through interview with the help of enumerators. For the face-to-face interview,

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farmers' home was visited. Respondents were aware about the study and objectives in detail. Interview was taken as per the farmers' convenience. After completion of each interview, proper checking and validation of the information was done. Though the interview schedule was in English, the questions were asked in the local languages.

Statistical Analysis

The collected data were analyzed using descriptive statistics. Data were tabulated and statistically analyzed using Microsoft Office Excel 2008 and SPSS 23. Qualitative information obtained from KII and FGD were first translated and interpreted to complement and supplement the quantitative information collected from household interviews.

Scaling and Indexing

Qualitative data regarding attitude of the respondents on problems faced by them on adaptation on climate change was ranked with the use of index. In scaling techniques, the intensity of problem being faced by farmers were identified by using five-point scaling technique comparing as most important, somewhat important, important, less important and least important using scores of 1.00, 0.80, 0.60, 0.40, and 0.20 respectively. The formula given below was used to find the index for intensity of various problems/reasons.

$$\text{Iprob} = \sum \frac{\text{Sifi}}{\text{N}}$$

Where,

I_{prob}= Index value for intensity of problem

S_i = Scale value of i^{th} intensity

f_i = Frequency of i^{th} response

N = Total number of respondents

RESULTS

Knowledge about Climate Change and its Source of Information

Respondents were asked whether they knew about term 'climate change' and it is found fourth-fifth of the total respondents have knowledge about climate change (Table 1).

Table 1: Knowledge of the respondents about climate change

Rural Municipality	Knowledge aboutclimate change		Chi-square value
	Yes (%)	No (%)	
Bardgoriya (n=60)	71.7	28.3	4.375
Janaki (n=60)	81.7	18.3	
Kailari (n=60)	86.7	13.3	
Total (N=180)	80	20	

Source: Field Survey (2019)

Respondent who reported having knowledge about climate change are further asked about how clearly they knew about climate change and found that only about 7% of them knew it very clearly and three-fifths of the total respondents have little bit knowledge on climate change and 28.5% have clear knowledge about climate change(Table 2).

Table 2: Level of information towards climate change

Rural Municipality	**Level of information on climate change**			**Chi-square value**
	Very clearly (%)	**Clearly (%)**	**Less clearly (%)**	
Bardgoriya (n=43)	7	18.6	74.4	5.866
Janaki (n=49)	10.2	26.5	63.3	
Kailari (n=52)	3.8	38.5	57.7	
Total (n=144)	6.9	28.5	64.6	

Source: Field Survey (2019)

About half of the total respondents know about climate change from their own experience. Similarly, 22.2% reported they have knowledge about climate change from radio/television and one-fifth said from their neighbors and relatives. Likewise, 3.5% have gained knowledge from farmer groups, 0.7% from government organization and 7.7 % from other source of information like newspaper, social media (Figure 2).

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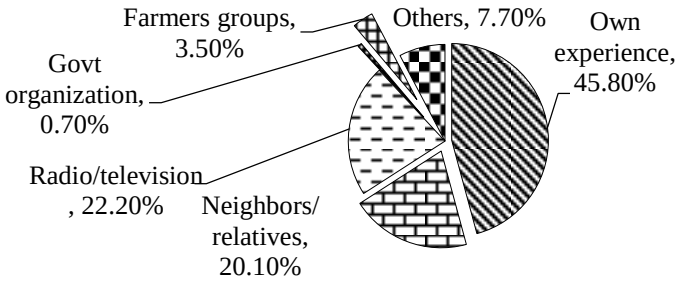

Figure 2: Sources of information about climate change
Source: Field Survey (2019)

Farmers' Perceptions towards Change in Temperature

Majority of respondents (91.7%) perceived that they have been experiencing increased temperature as compare to past ten years. Study found that 90% of respondents perceived day temperature is increasing.About third-fourth of the total respondents perceived night temperature is increasing ($p<0.01$).Majority of respondents (83.9%) perceived number of hot days are increasing ($p<0.01$). whereas, 5% reported it decreasing as compare to past years. Similarly, 72.2% of respondents perceived cold winter days are decreasing ($p<0.05$)(Table 3).

Table 3: Farmers' perceptions towards change in temperature (% response)

Perceptions of change in temperature		Rural Municipality			Total (N=180)	Chi-square value
		Bardgoriya (n=60)	Janaki (n=60)	Kailari (n=60)		
Overall temperature	Increasing	91.7	86.7	96.7	91.7	7.236
	Decreasing	0.0	1.7	0.0	0.6	
	Similar	8.3	8.3	1.7	6.1	
	Don't know	0.0	3.3	1.7	1.7	
Day temperature	Increasing	90	85	95	90	8.762
	Decreasing	0.0	3.3	1.7	1.7	
	Similar	10	11.7	1.7	7.8	
	Don't know	0.0	0.0	1.7	0.6	
Night temperature	Increasing	56.7	76.7	90	74.4	43.837***
	Decreasing	3.3	16.7	6.7	8.9	
	Similar	16.7	6.7	1.7	8.3	
	Don't know	23.3	0.0	1.7	8.3	
Number of hot summer days	Increasing	80	76.7	95	83.9	32.595***
	Decreasing	0.0	15	0.0	5	
	Similar	3.3	6.7	1.7	3.9	
	Don't know	16.7	1.7	3.3	7.2	
Number of cold winter days	Increasing	13.3	11.7	15	13.3	14.801**
	Decreasing	60	76.7	80	72.2	
	Similar	10	8.3	1.7	6.7	
	Don't know	16.7	3.3	3.3	7.8	

Note: ** and *** indicate significance at 5% and 1 % level
Source: Field Survey (2019)

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Farmers' Perceptions towards Change in Rainfall Pattern

Majority of respondents opined monsoon rainfall, winter rainfall, frequency and intensity of rainfall is decreasing whereas erratic pattern of rainfall is increasing as compare to past years.Nearly all of the respondents agreed that monsoon rainfall is in decreasing trend as compare to past years. About nine-tenth of the respondents agreed that winter rainfall and frequency of rainfall is decreasing simultaneously. Similarly, fourth-fifth of the total respondents reported rainfall intensity is decreasing ($p<0.01$). Result revealed fourth-fifth of the total respondents perceived as erratic pattern of rainfall is increasing (Table 4).

Table 4: Farmers' perception towards changes in rainfall pattern (% response)

Perceptions of change in rainfall		Rural Municipality			Total (N=180)	Chi-square value
		Bardgoriya (n=60)	Janaki (n=60)	Kailari (n=60)		
Monsoon rainfall	Increasing	3.3	5	1.7	3.3	3.012
	Decreasing	96.7	95	96.7	96.1	
	Don't know	0.0	0.0	1.7	0.6	
Winter rainfall	Increasing	10	5	5	6.7	11.542
	Decreasing	83.3	86.7	91.7	87.2	
	Similar	1.7	8.3	0.0	3.3	
	Don't know	5	0.0	3.3	2.8	
Frequency of rainfall	Increasing	3.3	8.3	3.3	5	3.684
	Decreasing	95	90	91.7	92.2	
	Don't know	1.7	1.7	5	2.8	
Intensity of rainfall	Increasing	33.3	6.7	5	15	25.546***
	Decreasing	63.3	88.3	90	80.6	
	Similar	1.7	1.7	0.0	1.1	
	Don't know	1.7	3.3	5	3.3	
Erratic rainfall pattern	Increasing	80	81.7	80	80.6	3.357
	Decreasing	11.7	8.3	15	11.7	
	Similar	3.3	3.3	0.0	2.2	
	Don't know	5	6.7	5	5.6	

Note: *** indicates significance at 1 % level

Source: Field Survey (2019)

Farmers' Perception of Onset and Withdrawal of Rainfall

Four-fifth of the respondents opined earlier onset of monsoon is decreasing and about three-fourth opined earlier withdrawal of monsoon is increasing. In case of winter rainfall earlier onset is reported decreasing by three-fourth of the total respondents. Nearly three-fifth of total respondentsreported increasing trend in earlier withdrawal of winter rainfall ($p<0.001$) (Table 5). It means people have been experiencing delay in both monsoon and winter rainfall which ends quickly suggesting decrease in number of rainy days.

Table 5: Farmers' perception on onset and withdrawal of rainfall (% response)

Perception on onset and withdrawal of rainfall		Rural Municipality			Total (N=180)	Chi-square value
		Bardgoriya (n=60)	Janaki (n=60)	Kailari (n=60)		
Earlier onset of monsoon rainfall	Increasing	20	18.3	13.3	17.2	4.880
	Decreasing	80	81.7	83.3	81.7	

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	Don't know	0.0	0.0	3.3	1.1	
Earlier withdrawal of monsoon rainfall	Increasing	76.7	65	70	70.6	12.349
	Decreasing	15	35	28.3	26.1	
	Don't know	8.3	0.0	1.7	3.3	
Earlier onset of winter rainfall	Increasing	10	28.3	11.7	16.7	22.999
	Decreasing	76.7	58.3	81.7	72.2	
	Similar	1.7	11.7	5	6.1	
	Don't know	11.7	1.7	1.7	5	
Earlier withdrawal of winter rainfall	Increasing	73.3	50	48.3	57.2	36.886***
	Decreasing	6.7	33.3	45	28.3	
	Similar	5	15	5	8.3	
	Don't know	15	1.7	1.7	6.1	

Note: *** indicates significance at 1 % level
Source: Field Survey (2019)

Farmers' Perception towards Climatic Hazards
The frequency of flood is decreasing in the study area was perceived by 59% of respondents. The hailstone occurrence is decreasing as perceived by 66% respondents. Increasing windstorm is perceived by 56% respondents. Similarly, foggy weather is perceived decreasing by 41% and four-fifth of the total respondents have been experiencing increased drought frequency (Figure 3).

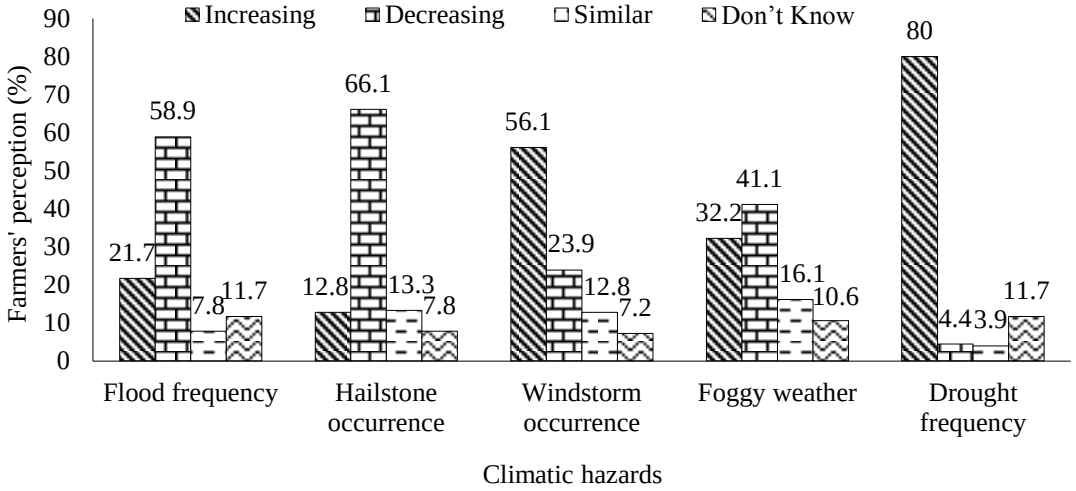

Figure 3: Farmers' perception towards climatic hazards
Source: Field Survey (2019)

Farmers' Perceptions towards Climate Change Impact on Agriculture
About 87% respondent perceived weed invasion is increasing ($p<0.05$). In case of new weed species, 37.8% perceived they found ($p<0.05$). About 92% of the total respondents perceived that disease and pest infestation is increasing. About 37% perceived that they found new pest and disease ($p<0.01$). Result showed that 71% respondents opined flowering and fruiting time of crops is changing ($p<0.1$). About 57% perceived local crop varieties loss ($p<0.01$). About 74% respondents reported climate change has effect on livestock health ($p<0.01$). Similarly, half of the respondents said livestock production is decreasing due to climate change ($p<0.01$).

About 74% respondents perceived that due to climate change natural water sources are drying up. Similarly, 84.4% opined the soil moisture level is decreased, ($p<0.01$). Around 98% respondents reported, irrigation requirement for crop is increasing as compare to past years due to climate

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change ($p<0.05$). Increased cost of agriculture production is perceived by 83% respondents ($p<0.05$) and 73% opined farm income is decreased due to climate change impacts on agriculture (Table 6).

Table 6: Farmers' perceptions towards climate change impact on agriculture (% response)

Perception on climate change impact on agriculture		Rural Municipality			Total (N=180)	Chi-square value
		Bardgoriya (n=60)	Janaki (n=60)	Kailari (n=60)		
Increase in weed invasion	No	16.7	10	0.0	8.9	10.558**
	Yes	80	85	95	86.7	
	Don't know	3.3	5	5	4.4	
New weed species found	No	58.3	28.3	5	30.6	47.755**
	Yes	15	35	63.3	37.8	
	Don't know	26.7	36.7	31.7	31.7	
Pest and disease infestation increased	No	5	6.7	1.7	4.4	5.762
	Yes	91.7	93.3	91.7	92.2	
	Don't know	3.3	0.0	6.7	3.3	
New pest and/or disease found	No	50	36.7	6.7	31.1	38.752***
	Yes	20	26.7	65	37.2	
	Don't know	30	36.7	28.3	31.7	
Change in flowering and fruiting time	No	8.3	3.3	1.7	4.4	8.374*
	Yes	58.3	78.3	76.7	71.1	
	Don't know	33.3	18.3	21.7	24.4	
Loss of local crop varieties	No	16.7	16.7	0.0	11.1	48.283***
	Yes	25	71.7	75	57.2	
	Don't know	58.3	11.7	25	31.7	
Effect on livestock health	No	6.7	10	6.7	7.8	24.916***
	Yes	55	80	86.7	73.9	
	Don't know	38.3	10	6.7	18.3	
Livestock production decreased	No	20	15	16.7	17.2	43.696***
	Yes	20	55	75	50	
	Don't know	60	30	8.3	32.8	
Water source dried up	No	20	23.3	15	19.4	5.142
	Yes	68.3	73.3	80	73.9	
	Don't know	11.7	3.3	5	6.7	
Soil moisture level decreased	No	15	13.3	1.7	10	23.512***
	Yes	70	86.7	96.7	84.4	
	Don't know	15	0.0	1.7	5.6	
Irrigation requirement increased	No	5	0.0	0.0	1.7	6.102**
	Yes	95	100	100	98.3	
Increased production cost	No	5	5	1.7	3.9	11.058**
	Yes	90	71.7	88.3	83.3	

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Perception on climate change impact on agriculture		Rural Municipality			Total (N=180)	Chi-square value
		Bardgoriya (n=60)	Janaki (n=60)	Kailari (n=60)		
	Don't know	5	23.3	10	12.8	
Reduced farm income	No	18.3	13.3	18.3	16.7	1.979
	Yes	71.7	73.3	75	73.3	
	Don't know	10	13.3	6.7	10	

Note: *, ** & *** indicate significance at 10%, 5% & 1 % level

Climate Change Adaptation Measures and Institutional Support in Agriculture

Household Involved in Climate Change Related Program

In the interview, respondents were asked if any of the family members involved in climate change related program viz. meeting, training, awareness campaign, workshop, seminar etc. Members from only 27% of the total households were involved in climate change related program (Table 7).

Table 7: Household involved in climate change related program

Rural Municipality	Involvement in climate change related program		Chi-square value
	No (%)	Yes (%)	
Bardgoriya (n=60)	81.7	18.3	3.239
Janaki (n=60)	70	30	
Kailari (n=60)	68.3	31.7	
Total (N=180)	73.3	26.7	

Source: Field Survey (2019)

Maximum programs related to climate change in which respondents' household involved are organized by cooperatives followed by government organizations and NGOs/INGOs. About 63% programs are organized by cooperatives, 23% by governments sector, 8% from NGOs/INGOs and 6% by other bodies ($p<0.1$) (Table 8).

Table 8: Organizer of climate change related programs in the study area

Program organizer	Bardgoriya (n=11)	Janaki (n=18)	Kailari (n=19)	Total (N=48)	Chi-square value
Government organization (%)	9.1	33.3	21.1	22.9	10.944*
NGOs\INGOs (%)	0.0	16.7	5.3	8.3	
Cooperatives (%)	90.9	50	57.9	62.5	
Other (%)	0.0	0.0	15.8	6.3	

Note: * indicates significance at 10% level

Source: Field Survey (2019)

Only about 3% responded highly satisfied with the climate change program organized in their locality (Figure 4).

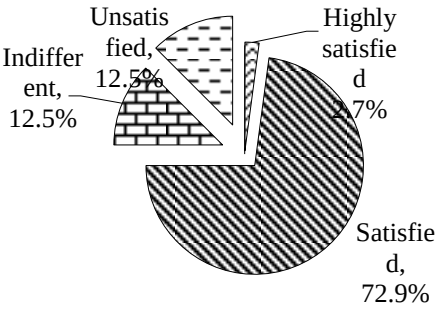

Figure 4: Farmers' satisfaction on climate change related programs

Source: Field Survey (2019)

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Farmers' Know-How on Agriculture Insurance

Half of the respondents have knowledge about crop and livestock insurance and remaining are not aware of that insurance ($p<0.05$) (Table 9)

Table 9: Farmers' know-how on agriculture insurance

Rural Municipality	Knowledge of agriculture insurance		Chi-square value
	No (%)	Yes (%)	
Bardgoriya (n=60)	53.3	46.7	6.179**
Janaki (n=60)	36.7	63.3	
Kailari (n=60)	58.3	41.7	
Total (N=180)	49.4	50.6	

Note: ** indicates significance at 5% level
Source: Field Survey (2019)

Out of 91 households who have knowledge about crop and livestock insurance were again asked if they have adopted agriculture insurance or not. Only three farmers have found adopted agriculture insurance. Among them, two households are from Bardgoriya Rural Municipality and one from Janaki Rural Municipality (Table 10).

Table 10: Household adopting agriculture insurance

Rural Municipality	Agriculture insurance adopting		Chi-square value
	No (%)	Yes (%)	
Bardgoriya (n=28)	92.9	7.1	2.204
Janaki (n=38)	97.4	1 2.6	
Kailari (n=25)	100	0.0	
Total (N=91)	96.7	3.3	

Source: Field Survey (2019)

Loan Taken for Coping with Climate Change Effects

For coping climate change adverse effect on agriculture, about 12% of the total households have taken agricultural loan (Table 11).

Table 11: Respondents taken loan for coping climate change adverse effect

Rural Municipality	Loan taken for coping mechanism		Chi-square value
	No (%)	Yes (%)	
Bardgoriya (n=60)	85	15	4.453
Janaki (n=60)	95	5	
Kailari (n=60)	83.3	16.7	
Total (N=180)	87.8	12.2	

Source: Field Survey (2019)

Information on Weather

About three-fourth of the respondents are aware of weather information (Table 12).

Table 12: Respondents having weather information

Rural Municipality	Weather information		Chi-square value
	No (%)	Yes (%)	
Bardgoriya (n=60)	25	75	0.061
Janaki (n=60)	23.3	76.7	
Kailari (n=60)	23.3	76.7	
Total (N=180)	23.9	76.1	

Source: Field Survey (2019)

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About 63% of the total respondents got information related to weather from radio followed by television (30.7%), newspaper (5.1%) and only 1.5% from farmer groups or cooperatives ($p<0.001$) (Table 13).

Table 13: Sources of weather information

Sources of information	Bardgoriya (n=45)	Janaki (n=46)	Kailari (n=46)	Total (N=137)	Chi-square value
Radio (%)	60	54.3	73.9	62.8	17.771***
Television (%)	37.8	30.4	23.9	30.7	
Newspaper (%)	0.0	15.2	0.0	5.1	
Farmer groups (%)	2.2	0.0	2.2	1.5	

Note: *** indicates significance at 1% level
Source: Field Survey (2019)

Respondents having weather information were further asked if their farm decision(i.e., planting, harvesting, threshing, irrigation, chemical application)are affected from information obtained or not. About three-fourth of the respondents' farm decision is affected by obtained weather information ($p<0.001$) (Table 14).

Table 14: Effect of weather information on farm decision making

Rural Municipality	Effect of weather information on farm decision			Chi-square value
	No (%)	Yes (%)	Don't know (%)	
Bardgoriya (n=45)	13.3	64.4	22.2	16.548***
Janaki (n=46)	23.9	73.9	2.2	
Kailari (n=46)	38	82.6	2.2	
Total (N=137)	17.5	73.7	8.8	

Note: *** indicates significance at 1% level
Source: Field Survey (2019)

Climate Change Adaptation Practice Followed by Farmers

From the group discussion various adaptation practice to minimize the adverse effects of climate change followed by farmers in the study area are listed. The majority of farm households have shifted planting and harvesting time (75.6%) followed by irrigation management (60.6%), mulching (60.6%), use of chemicals (53.3%) and crop variety change (51.1%). Similarly, change in land preparation practices (44.4%), agroforestry (30.6%), shift to non-farm activities (22.2%), crop type change (15%), using plastic tunnel (14.4%) are also found practiced by farmers in the study area (Table 15).

Table 15: Climate change adaptation practice followed by farmers (% response)

Adaptation practice	Non follower (%)	Follower (%)	Chi square value
Crop variety change	48.9	51.1	17.920***
Change in land preparation practices	55.6	44.4	11.115***
Crop type change	85.0	15.0	11.242***
Shift in planting and harvesting time	24.4	75.6	3.670
Mulching	39.4	60.6	.605
Agroforestry	69.4	30.6	26.758***
Irrigation management	39.4	60.6	8.420**
Plastic tunnel farming	85.6	14.4	4.406
Increased use of chemicals	46.7	53.3	10.848***
Shift to off-farm activities	77.8	22.2	7.971**

Note: *, ** and *** denote statistically significance at 10%, 5% and 1% level
Source: Field Survey (2019)

Government Support on Climate Change Adaptation

Only one-fifth of the total respondents got support from government sector on climate change adaptation program ($p<0.01$) (Table 16).

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Table 16: Government support on climate change adaptation

Rural Municipality	Government support		Chi-square value
	No (%)	Yes (%)	
Bardgoriya (n=60)	93.3	6.7	10***
Janaki (n=60)	73.3	26.7	
Kailari (n=60)	73.3	26.7	
Total (N=180)	80.0	20.0	

Note: *** indicates significance at 1% level
Source: Field Survey (2019)

Constraints on Adopting Climate Change Adaptation

Lack of proper information is the main constraints on adaptation practice followed by low level of awareness, limited support from government, poor technological know-how and lack of fund resources (Table 17).

Table 17: Constraints on climate change adaptation in the study area

Constraints	Index value	Rank
Lack of information	0.67	I
Low level of awareness	0.58	II
Limited support from government	0.57	III
Poor technological know-how	0.4	IV
Lack of fund resources	0.39	V

Source: Field Survey (2019)

DISCUSSION

Farmers' Perception on Climate Change

Although many farmers might not know about the term 'global warming' or 'climate change' but have clear and long experience of changing climatic parameters like rise in temperature, variability in rainfall pattern in their locality (Baul, *et al.*, 2013). Like that, farmers who responded having no knowledge about climate change are further explained in detail and found that they have been experiencing climate change but are not familiar with the terminology. Other studies also reported that most of the farmers are not aware about climate change (Piya, *et al.*, 2012) but are experiencing various climate induced risks (Thapa, *et al.*, 2018). Since farmers have been experiencing climate change but they have only limited knowledge and information about the climate change, its cause and mitigation measures. The result showed majority of the farmers know about climate change from their own experience followed by radio/television. Similarly,Piya, *et al.*, (2012) found major sources of information on climate change are radio, NGOs and school teachers in mid hills of Nepal. Though government and other sectors are doing so much on climate change but farmers revealed they got little support and forced to depend on their own experience and knowledge regarding climate change.

In Nepal, several climate change related studies have been conducted and included people's perception (e.g., Baul, *et al.*, 2013 (Dhading); Devkota, 2014 (Banke & Dang); Tiwari & Bauer, 2015 (Banke, Chitwan and Morang); Shrestha, 2015 (Kaski); Poudel & Shaw, 2016 (Lamjung); Sujhakhu, *et al.*, 2016 (Sindhupalchok); Budathoki, 2017 (Central Development Region); Regmi, *et al.*, 2017 (Chitwan); Thapa, *et al.*,2018 (Sunsari, Rupandehi, Banke & Kanchanpur). Regmi, *et al.*, (2017) studied farmers' perception in Chitwan district and found that as compare to past years warm days were increasing, cooler days were decreasing, level of water in Riukhola was deepening, rainfall pattern was unpredictable with decreased amount and number of rainy days in monsoon and drought period became longer. But the intensity of rainfall was seen increased which created floods and riverbank erosion. Thapa, *et al.*, (2015) found farmers perception as increasing temperature in Kailali district which support the findings. Similar to the result on perception about overall temperature increasing is supported by previous studies (e.g.,Tiwari, *et al.*, 2010; Rajbhandari & Shrestha, 2014; Shrestha, 2015; Tiwari & Bauer, 2015;Sujhakhu,, *et al.*, 2016). Several studies also suggested that both summer and winter temperature is increasing (Piya, *et al.*, 2012; Devkota, 2014) with longer summer and shorter winter season (Baul, *et al.*, 2013; Poudel &

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Shaw, 2016; Regmi, *et al.*, 2017; Chaulagain & Rimal, 2019) which support the findings. Whereas, some study also found that summer temperature is increasing but winter became cooler (Thapa, *et al.*, 2018).

Farmers' perception on decreasing rainfall is supported by various previous studies (e.g., Piya, *et al.*, 2012; Thapa, *et al.*, 2015; Tiwari & Bauer, 2015; Sujhakhu, *et al.*, 2016). Similarly, decreased winter rainfall as the result is reported by (Tiwari, *et al.*, 2010; Tiwari & Bauer, 2015;Sujhakhu, *et al.*, 2016; Regmi, *et al.*, 2017;Chaulagain&Rimal, 2019) in their studies. The result decreasing rainfall intensity is in contrast with Chaulagain and Rimal (2019) who found farmers' perception as increased rainfall intensity in Kailali district. Similarly other studies (e.g., Tiwari, *et al.*, 2010; Poudel & Shaw, 2016; Regmi, *et al.*, 2017; Thapa, *et al.*, 2018) showed increased rainfall intensity. Respondent perceived decreased intensity of rainfall may be due to their opinion on recent precipitation only. Several previous studies (e.g.,Tiwari, *et al.*, 2010; Rajbhandari& Shrestha, 2014; Shrestha, 2015; Thapa, *et al.*, 2015; Tiwari & Bauer, 2015; Poudel & Shaw, 2016; Sujhakhu, *et al.*, 2016; Regmi, *et al.*, 2017;Thapa, *et al.*, 2018;Chaulagain&Rimal, 2019) supported the result of increased erratic rainfall pattern.People have been experiencing delay in both monsoon and winter rainfall which ends quickly suggesting decrease in number of rainy days. Thapa, *et al.*, (2015) showed majority of the respondents in Kailali district perceived late arrival of rainfall which support the result. Similar findings about delay in monsoon and winter rainfall is reported by previous studies (e.g.,Tiwari, *et al.*, 2010; Piya, *et al.*, 2012; Baul, *et al.*, 2013; Sujhakhu, *et al.*, 2016). Whereas, Devkota (2014) stated that onset and withdrawal of monsoon rainfall is not certain.

Jones and Boyd, (2011) reported both intensity and frequency of flood is increased in Kailali district but the result showed more than 50% farmers perceived decrease in flood frequency. Other previous studies in different parts of Nepal also stated that the flood frequency is increased (e.g.,Joshi, *et al.*, 2011; Maharjan, *et al.*, 2011; Rajbhandari& Shrestha, 2014; Paudel, 2016; Regmi, *et al.*, 2017). While Chaulagain and Rimal, (2019) found majority of people perception as decreasing flood frequency in Kailali which support the findings. Several previous studies (e.g.,Tiwari, *et al.*, 2010; Maharjan, *et al.*, 2011; Ahmed & Suphachalasai, 2014; Rajbhandari & Shrestha, 2014; Paudel, 2015;Tiwari & Bauer, 2015; Sujhakhu, *et al.*, 2016; Regmi, *et al.*, 2017; Chaulagain & Rimal, 2019) reported increase in drought which support the result. Maharjan, *et al.*, (2011) found that hailstone occurrence is increased in Kailali district but in the study, respondent has perceived it as decreasing which is supported by findings of Thapa, *et al.*, (2015). This may be due to farmers gave answer regarding recent years hailstones occurrence rather long-term pattern. Maharjan, *et al.*, (2011) and Thapa, *et al.*, (2015) found that windstorm occurrence is increased in Kailali district which support the result. In case of foggy weather, Thapa, *et al.*, (2015) found most of the people perceived it as increasing and shifting towards upper region. While, the result did not show clear majority of farmers' perception whether it is increasing or decreasing.

Majority of respondents in the study area reported they have been experiencing decreased soil moisture level, and increased weed invasion, pest and disease infestation, cost of production and irrigation need than past years.Maharjan, *et al.*, (2011), Baul, *et al.*, (2013), Ahmed and Suphachalasai, (2014), Paudel, (2015), Tiwari and Bauer, (2015)reported similar result on increased weed infestation due to climate change. Also, Ahmed and Suphachalasai, (2014), and Chaulagain and Rimal, (2019) observed new invasive species in the crop field. Similar findings as increased pest and disease infestation is reported in various previous studies (e.g., NCVST, 2009; Lal, 2011; Baul, *et al.*, 2013; Ahmed & Suphachalasai, 2014; Paudel, 2015; Thapa, *et al.*, 2015; Tiwari & Bauer, 2015; Barrueto, Merz, Colt, & hammer, 2017; Hatfield,, *et al.*, 2018;Chaulagain & Rimal, 2019). NCVST, (2009) reported new pest infestation due to climate change which support the result. Many previous studies also observed change in flowering and fruiting time of many plant species (e.g.,Lal, 2011; Baul, *et al.*, 2013; Ahmed & Suphachalasai, 2014; Rajbhandari & Shrestha, 2014; Thapa, *et al.*, 2015; Tiwari & Bauer, 2015;Sujhakhu,, *et al.*, 2016) which support farmers' perception. Maharjan, *et al.*, (2011) reported loss of native species and local landraces due to climate change. Hatfield, *et al.*, (2018) reported adverse effect of climate change on livestock health and decline in livestock productivity. Tiwari, *et al.*, (2010), Regmi and Bhandari, (2012), Baul, *et al.*, (2013), and Tiwari and Bauer, (2015)also reported that water sources are drying up. In the previous

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studies by Baul, *et al.*, (2013), Tiwari & Bauer (2015), Dhakal, *et al.*, (2016), and Thapa, *et al.*, (2018) found that soil moisture level is declining which support the findings. Similar findings are observed in the previous studies by Pant, (2011) and Hatfield, *et al.*, (2018) which revealed increase in cost of production and decrease in farm production and income.

Climate Change Adaptation Measures and Institutional Support

In the study area agricultural insurance is found adopted by only limited farmers. Kaphle and Bastakoti, (2017) stated, farmers have low level of awareness and knowledge about agricultural insurance and also the supply of and demand for insurance is low in Nepal. In the study area, most of the loan is taken for frequent irrigation, time to time tillage and application of chemical fertilizers which is more needed due to adverse effect of climate change. It is observed that in many of the cases people took loan as agricultural purpose but spent on others.

Farmers are practicing adaptation measures according to their indigenous knowledge, skills, experience and farm needs (ICIMOD, 2009; Tiwari, *et al.*, 2010; Maharjan, *et al.*, 2011). Due to delay in monsoon rainfall farmers shifted paddy planting time about two to three weeks. Farmers having irrigation facility do not wait for rain and transplanted rice earlier but farmers who are depended on rainfall are forced to delay. Also, farmers started sowing wheat earlier than past years because of quick decrease in soil moisture. Similar findings of shifting the time of planting and harvesting is found by previous studies (Tiwari & Bauer, 2015; Dhakal, *et al.*, 2016). Zwane, (2019) focused on drought resistant crop varieties, judicious use of water resources for irrigation, sound use of fertilizers, organic matter composting despite burning, restriction on overgrazing and adopting suitable farming practices and strategies for mitigating climate change impact on crop and livestock production. Majority of the respondents established boring/pump-set and electric motor for irrigation, who are dependent on rain water in past and also increased frequency of irrigation. Several previous studies showed that farmers are coping shortage of irrigation water by improving irrigation methods and management (Tiwari, *et al.*, 2010; Piya, *et al.*, 2012; Krishnamurthy, *et al.*, 2013; Tiwari & Bauer, 2015; Dhakal, *et al.*, 2016; Budhathoki, 2017). Farmers are practicing mulching in vegetables like potato, onion, garlic which helps in maintaining moisture level. Lamichhane, *et al.*, (2016) reported that farmers are adapted mulching practice which supportedour findings. Farmers reported using more fertilizers, weedicides, and insecticides than past years to increase crop production (Tiwari, *et al.*, 2010; Rajbhandari&Shrestha, 2014; Shrestha, 2015; Tiwari & Bauer, 2015;Dhakal, *et al.*, 2016).

In the study area, farmers are attracted towards short duration, drought tolerant hybrid varieties. The result is supported by several studies which reported farmers have adopted hybrid varieties to cope with changing climate (ICIMOD, 2009; Maharjan, *et al.*, 2011; Piya, *et al.*, 2012; Krishnamurthy, *et al.*, 2013; Karn, 2014; Rajbhandari & Shrestha, 2014; Dhakal, *et al.*, 2016; Sujhakhu, *et al.*, 2016; Budhathoki, 2017; Shrestha, *et al.*, 2017). Farmers increased number of plowing and also started irrigating their field after rice harvesting to maintain soil moisture for wheat. The finding increased in number of plowings is in contrast with Lamichhane, *et al.*, (2016) which reported minimal plowing as adaptation measure. Tiwari, *et al.*, (2010),Dhakal, *et al.*, (2016), and Sujhakhu, *et al.*, (2016) reported that farmers are started agroforestry and plantation of trees as adaptation measure similar to the findings. Also, it is found that people have shifted their occupation to non-farm businesses rather than farming only (ICIMOD, 2009; Tiwari, *et al.*, 2010;Piya, *et al.*, 2012). Several studies reported that farmers are involved in planting maize and sugarcane instead of rice and also attracted towards vegetable cultivation than cereals (Gurung & Bhandari, 2009; ICIMOD; 2009; Tiwari, *et al.*, 2010; Maharjan, *et al.*, 2011). In the study area farmers are cultivating vegetables (capsicum, chilli, tomato, brinjal) in plastic tunnel are increasing which is also reported in the previous study by Lamichhane, *et al.*, (2016), and Sujhakhu, *et al.*, (2016).

Karn, (2014) and Shrestha, *et al.*, (2017) suggested, as monsoon temperature is in increasing trend there will be need of heat tolerant rice varieties for upcoming years. Tiwari and Bauer, (2015) stated that farmers are mainly focused on irrigation management to minimize climate change impacts. Beside this they have practicing various agronomical practices like crop rotation, crop diversification, shift in planting and harvesting

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time, use of mulch, compost manure, agroforestry, farming in plastic tunnels (Tiwari & Bauer, 2015). The conservation agriculture practices like crop rotation, decrease in plow number, crop residue mulching helps to reduce the adverse effect of climate change for farm households and improves their economy (Kataki, *et al.*,, 2001). While farmers were using excessive chemicals and planting improved and hybrid varieties to ensure better crop production from climate change (Tiwari & Bauer, 2015). Dhakal, *et al.*, (2016) identified farmers were using more hybrid varieties, chemical fertilizers, alternate irrigation methods, and improved production technologies to get higher crop yield. Also, farmers replaced maize and pulses with sugarcane and vegetables, shifted paddy cultivation time and started planting fruit trees in upland and where productivity was low (Dhakal, *et al.*, 2016). It was found that farmers increased use of chemical fertilizers, pesticides, hybrid seeds and change farming system to cope against climate change and increase food production (Rajbhandari & Shrestha, 2014; Shrestha, 2015). Sujhakhu, *et al.*, (2016) stated different adaptation practices like planting drought and flood tolerant varieties, multi cropping, agro-forestry, water resource management, which increase the adaptive capacity of farmers. Similarly, adaptation measures like plastic tunnel farming, off season vegetable cultivation, improved seed production and seed storage, conservation agriculture, and irrigation management help to cope with negative impacts of climate change (Paudel, 2015). Pandey, (2012) reported that farmers are not much benefited by governments' effort on reducing climate change impact so that there is a lot to do in adaptation process. Also, in Nepal the adaptation measures are affected by unstable government, officials having limited knowledge on climate change and unavailability of genuine data and records (Pandey, 2012). People perceived that for better adaptation they don't have reliable information and technology and also government support and service is not enough and effective (Regmi & Bhandari, 2012).

Lamichhane, Ranabhat, Koirala, and Shrestha, (2016) identified that higher education level of farmers, more member from working age group, big farm size, accessibility to credit, good extension services, high annual income increases the probability of adopting different adaptation strategies. Similarly, Khanal, *et al.*, (2018) concluded that adaptation to climate change is determined by various socio-economic factors like education level of farmer, accessibility of credit system, size of landholdings, and availability of climate information. Furthermore, result suggested high probability of employing adaptation by those farmers, who were affected more by drought and floods, who were experiencing change in local climate and who believe adaptation helps to reduce negative impacts of climate change (Khanal, *et al.*, 2018). Maharjan and Maharjan, (2017) revealed that people with high resource and adaptive capacity have more ability to cope climate change impact but the adaptation may be affected by various factors like socio-economic, national policies and human, natural and physical capital. Gurung and Bhandari, (2009) stated that adaptation measures should developed considering socio-economic condition of locality. Similarly, Tiwari, *et al.*, (2015) stated that for reducing climate change adverse impact adaptation measures should be find out and practiced with considering type of crops and its growing location and season. Regmi, Shrestha, Baral, and Rajbhandari, (2018) suggested that availability of improved seeds and fertilizers, trainings on climate change adaptation and integrated nutrient management, weather forecasting, and early warning system should be provided to all farmers to minimize climate risks.

Though there are advanced technology and media access but still majority of farmers got weather information from radio. It is observed that majority of farmers' decision is affected by weather information and they got chance to manage their farm activities according to suitability of climatic condition. Khanal, *et al.*, (2018) reported that adaptation measure is determined by availability of climate information. Result showed that farmers in the study area did not have proper information about climate change, its impact and adaptation measures whereas they are also not motivated to try and practice new adaptation measures. Lamichhane, *et al.*, (2016) reported that adaptation measures on agriculture by farmers are positively influenced by having higher education level of farmers, accessibility with extension services, credit facility and high-income level. It is observed that farmers are not well equipped with improved technology (drip irrigation, insurance etc.) and did not have enough income sources for adaptation measures. In the study area government has supported farmers mainly by providing irrigation

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facility as establishment of boring, cannel irrigation and distribution of farm tools. Pandey, (2012), and Regmi and Bhandari, (2012) stated that government support on adaptation process is limited and not effective at farmers' level. Guo, (2016) suggested that government should teach and emphasize practicing adaptation measures like crop diversification, use of improved seeds and technologies to the farmers to mitigate adverse impacts of climate change. Furthermore, government support is limited to commercial farmers and large farm holdings whereas majority of farmers' livelihood was still at stake.

CONCLUSION

Farmers perceived climate change as a rise in temperature, decrease in rainfall, delay in monsoon and winter rainfalls, and increase in drought frequency in Kailali district. Farmers observed increase in weed invasion and insect pest infestation, decrease in soil moisture, increased crop water demand and increased cost of production due to climate change.Farmers have been coping with the adverse impacts of climate change by the adjustments in the farming practices, mainly by shifting planting and harvesting time. Along with these, farmers have also been following other climate change adaptation measures as irrigation management, mulching practices, increased use of chemicals against disease/pests, and change in crop varieties for increasing agricultural production and improving food security status of households. Whereas, inadequate access of farmers to information and improved technologies, and low level of institutional support hamper climate change adaptation measures which make food security of farm households at stake.

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