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Climate change and maize agriculture among Chepang communities of Nepal: A review

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ABSTRACT

This paper reviews recent literature concerning effects of climate change on agriculture and its agricultural adaptation strategies, climate change impacts on Chepang communities and their maize farming. Climate change is perhaps the most serious environmental threat to agricultural productivity. Change in temperature and precipitation specially has greater influence on crop growth and productivity and most of these effect are found to be adverse. Climate change has been great global threat with global temperature rise by 0.83 °C and global sea level rise by 0.19 m. Poor countries of the world are more vulnerable to changing climate due to different technological, institutional and resource constraints. In context of Nepal, practices like tree plantation, lowering numbers of livestock, shifting to off farm activities, sloping agricultural land technology (SALT) and shifting cultivation are most common coping strategies. Chepang, one of the most backward indigenous ethnic groups of Nepal are also found to perceive change in the climate. Perception and adaptation strategies followed by different farmers of world including Chepang is mainly found to be effected by household head's age, size of farm, family size, assessment to credit, information and extension service, training received and transportation. Maize is second most important crop in Nepal in which increase in temperature is favorable in Mountain and its yield is negatively influenced by increase in summer rain and maximum temperature. Local knowledge of indigenous people provides new insights into the phenomenon that has not yet been scientifically researched. So, government should combine this perceptive with scientific climate scenario and should conduct activities in term of adoption strategies and policies to insist targeted and marginalized farmers.

Keywords: Climate change, maize farmers, coping strategies and Chepang communities.

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INTRODUCTION

The world now faces one of the most complex issues which it has ever had to deal with: climate change. Climate change at present has moved from being hypothesis to being reality and has became a important global threat to all economic sectors, being agriculture a major one. Developing countries like Nepal is more adversely affected by the negative effect of changing climate and rank 9thin Global Climate Risk Index in terms of exposure to various extreme climate (Sönke et al., 2015). Nepal has agrarian economy where agriculture contributes about 33.1% to total GDP (MoAD, 2014). Despite of its significant share to the overall economy, agriculture sector faces serious challenges from changing climate induced impacts like rising temperature, droughts, flood, increasing disease, pests and loss in yield. Agriculture here is the important source of support for the majority of Nepalese households, adapting the agricultural sector mainly for negative effects of climate variability is necessary to assure food security for country and to protect livelihood of Nepalese households. Adaptation to changing climate is an effective tool at the farm level to reduce climatic vulnerability by making Nepalese farmer able to prepare themselves and their farming to changes and variability in climate along with avoiding projected damages and boosting up them in dealing with adverse events (IPCC, 2001).

Chepangs are earliest known inhabitants in Nepal and one of the most backward indigenous nationalities occupying 0.23% of national population. Hills of Chitwan, Makwanpur, Dhadhing and Gorkha are major habitat for Chepang community where 95% of total Chepang are dwelling since long ago. Chepang falls under the highly marginalized category both spatially and socioeconomically. The literacy rate of Chepang community is only 13.9% (CBS, 2003) which hampers their participation in administrative and economic sectors. Chepangs live in the wildest imaginable state of nature and many of them still lead a primitive life. They are well known for shifting cultivation practice which is the main source of livelihood for almost all of them. Agriculture farming is main source of their food but farming alone is not enough to sustain their family food requirements for the whole months in a year. Other traditional occupations are hunting, fishing, and collecting edible shoots and roots, wage laboring and salary job are also done for cash income. Like other part of world Chepang people are also facing various changes in climate and are formulating their own adoption strategies for to prevent fluctuation in their agricultural production. Adoption strategies like changing planting time, using drought and heat resistant variety, adoption of agro forestry, development of water conservation techniques and diversification of off farm activities are very common among Chepang communities.

Maize is second most important crop on Nepal which is cultivated in 2145291 hectare area. Its total production is about 882395 metric tons. Its average productivity is 2400 kilograms per hectare. The Hill area that extended from east to west is the most important maize growing area. Eastern, Central and Western Hill are the highest maize growing areas of the country. Chitwan district ranks first in maize production where as Kavre and Tanahun districts rank second and third position respectively. Productivity of maize is found to be highest at Kathmandu. Like as other crops maize is also influenced by climatic change and most effects have negative impact on yield and productivity. Different adoption strategies have been adopted at local level and its

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more explanation and exploration can be a best strategy for to increase economic importance from maize at present context.

Although various study has already been done about climate change but very few studies can be found regarding perception of indigenous community like Chepang community towards climate change. So this study tries to focus on indigenous farmers indicating what perception they have to the impact of climate change on agricultural production, different problem they have faced and how they cope with these changes. Furthermore it will also highlight on factors that influence on farmers choice of adaptation strategies and what is the effect of such strategies on farmer's crop production and food security. Moreover this finding will also be fruitful for policy makers and stakeholders who are concerned in agricultural development, poverty alleviation, food security as well as the disaster management. The overall objective of this review is to gather knowledge about climate change and agriculture along with different mitigation measure adopted at different part of world including adoption strategies followed by Chepang community.

DISCUSSION

Climate change and its effect on agriculture

IPCC, Intergovernmental Panel on Climate Change has defined climate change as any types of changes that occurs on climate over time which arises as a result of both human activity and natural variability where as UNFCC (United Nations Framework Convention on Climate Change) defines climate change as a change in climate that is contributed directly or indirectly to human activity that influence the composition of global atmosphere.

The Food and Agriculture Organization (FAO) states that considerable efforts need to be done to prepare developing countries to deal with climate-related effects, especially in agriculture (FAO, 2007).Through the recent study IPCC noted that there are viable adaptation options that can be implemented at low cost along with high benefit-cost ratios (IPCC, 2007).

IPCC in its fifth assessment report has stated that the anthropological emission of green house gases are increasing day by day and has became the highest in history at the present condition which has various impacts on human and natural system. Due to these gases atmosphere is warming, snow is malting and sea level is rising. The global temperature has risen by 0.85°C (0.65-1.06 °C) from year of 1880 to 2012 where as global sea level has raised by 0.19m (0.17-0.21m) over a period of 1901 to 2010 .The increase in global mean temperature at the end of twenty first century (2081-2100) compare to 1985-2005 is expected to be in between 0.3°C to 4.8 °C and seal level is expected to rise between 0.26- 0.82m in the same period of time. Also, change in precipitation is expected to be irregular with increase in mean annual rainfall in high altitude and decrease in mean annual rainfall in mid altitude dry reason. Anthropogenic gases emission in atmosphere has increase the concentration of carbon dioxide, methane and nitrous oxide. Among total anthropogenic carbon dioxide emitted 40% remains in atmosphere where as 30 % is absorbed by ocean leading to ocean acidification and rest is absorbed by land causing various bad effects (IPCC, 2014).

Developing countries like Nepal contribute very less to global green house emission but these are the one most affected by the effect of climate change. Nepal contributes 0.025 percentage to green house emission but is ranked 4th on Maplecorft's climate vulnerability index (Maolecorft,

2011).Nepal is experiencing increase in temperature, erratic rainfall, irregular onset of monsoon which has increased the vulnerability of glacier lake outburst, drought, landslide and flood. Temperature of the country is increasing gradually (Shrestha et al., 2000; Ebi et al., 2007). While the precipitation has been more erratic, heavy and unpredictable with more droughts and shorter periods of winter rainfall (Shrestha et al., 2000). Annually precipitation of Nepal is increasing by 13mm and days of rainfall are decreasing by 0.8 days per year (Manandhar et al., 2011). Flood at Koshi river at eastern Nepal in 2008 and flood at west Rapti at western Nepal in 2012 is a good example of devastating flood in Nepal (Sinha et al., 2008). Mainly western part of Nepal around west Rapti river basin is experiencing more than expected flood resulting heavy damage in human lives, their properties and serious losses in agricultural production every year (Marahatta et al., 2009) .In case of mountains of Nepal for over thirty years snow covers has been reduced, glacial area has been depleted by about 21 % and here tree line has been shifted to higher altitude (Synnott, 2012) where as in hill there has been change in intensity and timing of rainfall along with high incidence of pest. Lastly in terai, incidence of flood has been increased due to melting of snow and different glaciers outburst (Blunden et al., 2012).In context of Chitwan monsoon rainfall varies from year to year and is decreasing in trends in long term basis where as whereas summer and winter temperature increasing over a period of time (Pandey & Neupane, 2017) .

Climate change seems to have more impacts on large animals then in smaller ones. At the current situation climate change has been considered as an additional factor which along with other conventional pressures can have a significant effect on the scale, form and temporal and spatial effect on agricultural production. In the absence of proper strategies to long lasting climate change and climatic variability, different diverse and region-specific impacts will become more prominent and apparent. Most of the impacts of climate change are found to have negative effect on agriculture where as others are found to be favorable. Climate change has potential to influence crop and livestock production, input supplies, hydrological balance and other components of agriculture system. It can also change frequencies, intensities and type of various crops and livestock pests, severity of soil erosion, availability and timing of irrigation water supplies and also affects demand of labor, energy and equipments (Adams et al., 1998). It is very important to consider agriculture sector in term of climate change as it get affected by changing climate as well as contributes to climate change (Aydinalp & Cresser, 2008). Due to various factors effects of climate change on the agricultural sector have increased its concern over the magnitude of future global food production (IPCC, 1996).

Different component of climate like temperature, solar radiation, rainfall, wind velocity and relative humidity in combination or individually may influence crop growth and productivity (Ghimire, 2008)**.**In higher and middle altitude higher temperature will lengthen season of growing along with extending area of crop production pole ward where as at the lower latitude higher temperature will inversely affect the growing condition especially in areas where temperature are close to optimal temperature required for the growth of crop. Change in temperature and precipitation affects irrigation availability and demand. Increase in temperature causes increase in potential evapo transpiration which will intensify stress due to drought especially in tropics, subtropics and semi arid (Rosenzweig & Hillel, 1995). Based on agronomic research in countries of lower latitude approximate global welfare changes in the agricultural sector (without adaptations) has losses of US$61.2 billion and gains of US$0.1 billion which is

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in contrast with the losses of US$37 billion to gains of US$70 billion with appropriate adaptations in same place (Reilly, et al., 1996).

In Africa and South and East Asia decline in aggregate production is anticipated which showed that in Asia rice production may decline by 3.8 percent of production level under likely future climate regimes. In addition it is also accepted that negative effect of climate change in agriculture will increase the severity of incidence of poverty in rural areas (Murdiyarso, 2000).

In addition to crops climatic change also have various impacts on livestock. Different indirect impacts like reduction in forage and grass productivity, decrease in productivity of crops used as feed for poultry and live stocks, increase in water shortage and increase in distribution and severity of human livestock and crop disease (Hahn et al.,1992) where as direct impacts in livestocks due to climate change includes reduction in milk production and conception rate in dairy animals during summer season (Klinedinst et al., 1993)

Agricultural adaptation strategies to climate change impacts

Adaptation to climate impacts in general condition and in the sector of agricultural sector has been well introduced phenomenon. Different natural and socioeconomic systems have continuously been adapting autonomously where as in some places adaptation is in accordance with a plan of changing environment (Rosenberg, 1992).Adoption strategies for climate change in agriculture are mainly of two types – short term adaptation strategies and long term adaptation strategies.

Short term adaptation strategies include activities like improve nutrient management, diversification in crop and livestock and variation in time of farm operation, temporary migration, crop and livestock insurance etc. Contouring, terracing, construction of divisions and water storage can reduce the effects of climate change by reducing soil erosion, runoff and promoting nutrient storing capacity of soil (Easterling, 1996; Gylling & Abildtrup, 2001). Along with increase in temperature and change of climate, outbreak of different disease and pests become very common. This can be reduced by appropriate application of proper pesticides and adopting proper integrated insect and pest management techniques (Downing et al., 1997). Agro forestry can be a useful climate change adaptation strategy. In 2002 Adesina and Chianu enlighten that in case of Nigeria ,adaptation to agro-forestry as a tool for coping climate change vulnerability was significantly found to be effected by gender of farmer, experience of agro-forestry , contact with extension agents, fuel wood pressure, land pressure ,distance from urban area and importance given for livestocks as economic activities. Meanwhile human capital variables were found to be significant for taking decisions regarding adaptation and modification of required technology. Moreover, changing the sowing time, planting, spraying, adjusting the cropping sequence and harvesting can be used to take advantage of the changing duration of growing seasons and associated heat and moisture levels (Brklacich et al., 2000). IPCC (2001) has discussed insurance which may be informal and formal as well as public and private as a potential measure to reduce negative losses that arises from climate related impacts.

Long term adaptation strategies include – changing crop types and location, water management, developing new technology and modernization, permanent migration etc. One of the best options for climate change is to switch to more robust varieties which show better result in new environment. Matarira and Mwamuka (1996) reported that in Zimbabwe farmer has successfully switched to use more drought tolerant crops where drought has made difficult to use traditional

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crop varieties. In extreme cases farmers have converted agricultural land into game ranching. Similarly watershed and landscape management, law and regulation, use of economic instruments, efficient and effective weather forecasting system, flood risk management system, rising awareness and data bases related to flood can also be used to mitigate vulnerabilities of climate change (Kundzewicz, 2002). Proper water management technique can also reduce effects of climate change. Bullock and others (1996) state that when there is short supply of water advance irrigation practices like underground irrigation and drip irrigation can be used which helps in water conservation up to 50 percent in comparison to conventional ones.

In high Himalayan region of Nepal adaptation strategies for climate change were found to be very limited. Farmers in this region stated that due to the decline in grass land and grass production they are lowering their livestock numbers and had practiced rotational grazing where as shifting cultivation by farmers and engaging in hotel business or migrating to other places were also found to be common. Likewise farmers in Siwalik and mountain have been managing community forests, water harvesting and adopting Sloping Agriculture Land Technology as an agro-forestry (Herto-Silviculture) practices in their steep land to lower soil erosion and Chepang in Siwalik are minimizing their shifting cultivation. Moreover, majority of farmers were also found to be busy in practicing vegetable production rather than cereal production. Lastly, in terai farmers are developing community forest and planting trees in their private lands. They have adopted irrigation cannels and pumps for to meet water requirement of their field and have done river training and embankment in order to protect their agricultural field. In addition they have also adopted use of high yielding variety, chemical fertilizers, insecticides and pesticides (Tiwari et al., 2010).

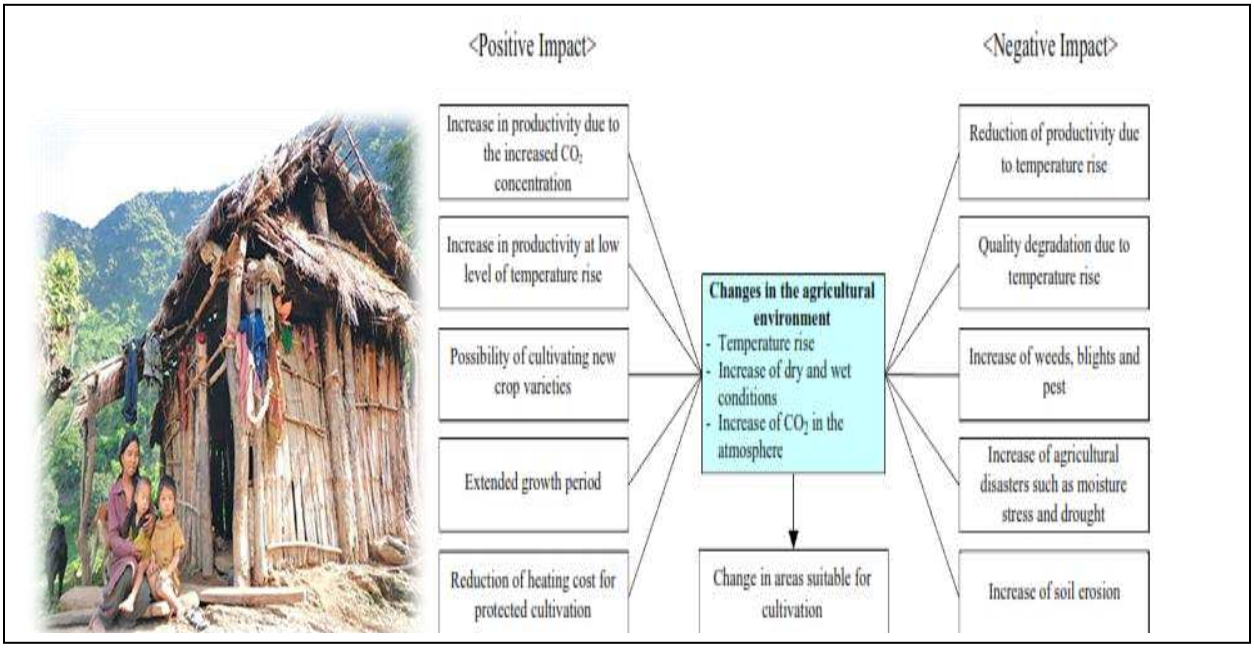

Figure 1: Potential impacts of global warming on the agricultural sector and farmers' livelihood (Source: adopted by Chang-Gil, et al. 2009).

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In context of Ethiopia change in varieties of crops, water and soil conservation, tree planting, early and late planting and harvesting, and irrigation were major adoption strategies for climate change (Temesgen et al., 2009).

In Bangladesh farmers were found to adopt fourteen adoptation strategies for to mitigate adverse effects of climate change which were-increased irrigation, integrated farming system, crop diversification, use of salinity tolerant varieties, use of drought tolerant varieties, crop rotation, cultivating short duration crops, practicing intercropping, engage in off-farm job, moved to non-farm activities, agro forestry, soil conservations techniques, zero tillage and crop insurance. Amoung these different adoptation irrigation rank first and crop insurance rank last (Mohammed et al., 2014).

Factors affecting adoption of climate change adaptation strategies

Along with the experience of climate change farmers are adopting different strategies to deal with its adverse effects but these strategies are found to be effected by different determinant. Climate change adaptation strategies adopted by farmers are found to be effected by accurate and frequent climatic information from meteorological centre, credit assessment and information about extension, involve in formal and informal institutions, rainfall amount, geographical location, age ,size of household and education status of household head (Yesuf et al., 2008). Assessment of electricity and other technology, land ownership, market facilities and gender of household head found to have significant influence on household choice in adaptation to climate change (Nhemachena & Hassan, 2007) while poverty, lack of well secure property rights, poor savings, size of farm, poor technical skills and non-farm employment acts as additional barriers to adoption of different strategies for climate change. Similarly livestock ownership, amount of precipitation and local temperatures also helps in determining the household's choice while adapting strategies to climate change (Yesuf et al., 2008) .

A research done at Chepang community showed that conventional adaptation strategies to climate change are found to be influenced by landholding size, land tenure status, perception about climate change, credit assessment, extension and information service, training related to skill development and access of transportation service which enables farmers to adopt new practices to cope climate vagaries (Piya et al., 2013). In Bangladesh age, education, size of family, farm size, income of family and involvement in cooperatives were significant factors for self reported adoption strategies. In this case it has been found that age, farm size and family size were found to have significant negative effect where as education, farm income and involvement in cooperatives were found to have significant positive impact. Lack of availability of water, shortage of land for cultivation, and unpredictable weather are ranked as highest constraints for respondent group to tackle with environmental change effect and degradation (Mohammed et al, 2014).

Adoption choices of farmer's of Nile river basin of Ethiopia are influenced by gender, education, age, and wealth of the head of household, assessment to credit and extension, climatic information, agro ecological settings, social capital and temperature where as major barrier were poor information on adaptation methods and financial constraints (Temesgen et al., 2009). In the same way adoption in Swaziland is significantly affected by household head's age, membership in social group, category of land, availability of credit, assessment to extension service and training, incidence of pest and disease, high price of inputs and food. In contrast

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education and sex status of head of household is insignificant to adoption to climate change (Shongwe et al., 2014). Charles and Rashid (2007) identified that assessment to credit and extension and climate change awareness are some of the important determining factor for adaptation at farm level in South Africa, Zambia and Zimbabwe.

Figure 2: Different dimensions of adaptation (Source: Peterson & Stafford, 2009)

Climate change impacts on Chepang community

Vulnerability of climate change is increasing day by day is highly threatening human livelihood. In comparison to urban, rural communities especially of developing countries are expected to affect more because of their extensive dependence on climate sensitive options and limited adoptive strategies to the changes (UNFCCC, 2009). Local community study local climate closely and adopt different strategies .These incorporating indigenous knowledge could play significant role in mitigating increasing risk of changing climate (Nyong et al., 2007) Chepang are marginalized indigenous ethnic groups of dwelling at rural mid hills of Nepal and are highly vulnerable to climatic changes. One third of the Chepang farmers under study were found to perceive change in climate. Most commonly observed climatic hazards in Chepang community are landslides, drought and hailstones. In these community drought has been more frequent. Short duration droughts followed by uncertain rainfall have highly hampered maize cultivation. Hailstone is also occurring more frequently mainly during April to May and has effect crops like maize, orange and pear. In major dwelling areas of Chepang there is late unset of winter rain which mainly lead to late sowing of maize and delay in millet transplantation (Piya et al., 2012)

A survey from Chepang community of Chitwan revealed that 95 percent of local people surveyed perceived changes in temperature where majority of them noticed increase in temperature and few perceive decrease in it. In addition unpredictable rainfall was also observed by them where as only two percent farmers noticed predictable and constant rainfall. Increase in drought, hail storm abnormality, decrease in water sources, change in flowering and fruiting time , disappearance of some indigenous plant and invasion of new weeds are different effect seen by Chepang of Chitwan district of Nepal as a result of climate change (Thapa & Shah, 2010). In another research done in Chepang community of Siddhi and Shaktikhor showed that, 50 percent of the respondents perceived increase in summer temperature, 20 percent perceived a decrease in summer temperature, 6 percent perceived neither increase nor decrease and 24 percent of respondents were not aware about change in summer temperature pattern. 39 percent of

respondents perceived increasing in winter temperature, 37 percent perceived decrease in winter temperature, 3 percent perceived neither increase nor decrease and 21 percent of respondents were not aware about change in winter temperature pattern. Similarly 58 percent perceived decrease in rainfall amount as compared to past while 57 percent respondent perceived decrease in duration of rainfall. 49 percent respondents perceived that rainfall time is unpredictable (Pandey & Neupane, 2017) .Perception of temperature and rainfall change is mostly effected by access to information and extension service. Similarly perception of rainfall is also significantly affected by the cultivation of cash crops where as engagement in off farm income sources and formal education reduce the ability of local farmers to perceive changes in climate (Piya et al., 2012) . Most common climate change copping strategies by Chepang are varietal selection, adjustment in time of sowing ,different soil conservation practices, wild eadible collection, nonfarm job, wage laboring, rearing livestocks, cash crops, water pond construction and depending upon community for assistance (Piya et al., 2013) where as another study showed that forest plantation, crop diversification, marginal land utilization by planting millet, grasses and trees are most common adoption practices of Chepang farmers (Thapa & Shah, 2010)

The conventional adaptation strategies to climate change followed by Chepang community are influenced by landholding size, land tenure status, perception of climate change, access to information, productive credit and extension service, skill development training and access of transportation service which enables farmers to adopt new practices to cope climate vagaries (Piya et al., 2013)

As climate change is all throgh the world peoples in each sectors are using their own strategies to tackel with these changes.In Ethiopia people are using varieties of crops, water and soil conservation, tree planting, early and late planting and harvesting and irrigation were major adoption strategies and gender, education, age, and wealth of the head of household, assessment to credit and extension, climatic information, agro ecological settings, social capital and temperature are influencing factor for their choices (Temesgen et al., 2009) .Similarly in case of increased irrigation, integrated farming system, crop diversification, use of salinity tolerant varieties, use of drought tolerant varieties, crop rotation, etc are major practices where age, education, family size, farm size, family income are significantly related to these adoption practices where education, age, size of family, size of farm and family income are significantly related to adoption practices (Mohammed et al., 2014). in Swaziland is significantly affected by household head's age, membership in social group, category of land, availability of credit, assessment to extension service and training, incidence of pest and disease, high price of inputs and food. In contrast education and sex status of head of household is insignificant to adoption to climate change In Swaziland farmers has adopted varieties resistant to drought, irrigation, switching of crops, crop rotation, early planting, late planting, mulching, intercropping and minimum tillage. These practices are found to be significantly affected by household head's age, membership in social group, category of land, availability of credit, assessment to extension service and training, incidence of pest and disease, high price of inputs and food (Shongwe et al., 2014).

All these shows that as per the intensity and vulnerability of climate change people are adopting their own strategies. As compare to others adoption followed by Chepang are more traditional, old and primitive types. Study showed that there is very less information available about Chepang, their perception and adoptation. So priority placement must be done for the

dissemination of relevant information from community level and regular updating educational curriculum by including issues related to climate change need to be done .In addition local hyrological station need to established and proper community training need to be done for local people in order to generate local climate based data and to facilate awareness and adaptation in local level.

Climate change impacts on maize farming

Maize is second major crop of Nepal and is considered as a major crop in Hills. Date of sowing is determined mainly by soil moisture availability. As maize is C4 photosynthetic pathway crop, it has less response to atmospheric change in carbon dioxide level. Maize production was increased by 9% in terai, 4.9% in hill and 14.5 % in mountain where as yield decrease by 26.4% in terai and 9.3 % in hill but found to be increased by 26.8 in mountain at 4°C rises in temperature. This showed rose in temperature is favorable for growing maize in mountain in comparison to terai and hills (Nayava and Gurung, 2010).Research has shown that, in context of Nepal, rise in summer rainfall and maximum temperature negatively affect yield of maize. It has suppressed yield of maize by 106 kg/ha (Joshi et al., 2011).

Climate is changing although the world, including the major maize-growing state of Iowa in the USA. In Iowa to maintain crop yields, farmers need adopt different adaptation strategies. Choice of their strategy will depend on how regional and local climate in particular area is expected to change. Maize yields from late 20th century to middle and late 21st century is predicted to range from 15% to 50%. Similarly for each 1°C rise in air temperature in warm season 6% state-averaged yield reduction is predicted. Research results suggested that even if maize receive all its water requirement under strong climate force scenario yields will decrease by 10–20% by the end of the 21st century(Xu et al., 2016). Overall reduction of in maize production up to 2055 is expected to be 10 % whose loss will be equivalent to $2 billion per year. Climate change needs to be assessed household level, so that research and development activities can target poor and vulnerable people depending on agriculture with the objective of alleviation of poverty (Chang et al., 2014).

Finding from research done on China show that climate change has a adverse effect on Chinese agriculture and has caused high flexibility in the timing of maize production and in southwest region a better adaptation to climate change in regional level can help to offset or even to outweigh potential reduction in production of maize in the Northeast region. Research suggest proper inter-regional cooperation, contracts and policies need to be made for the stabilization of agricultural labor force at regional level as a cost-efficient risk mitigation strategy to decrease overall maize production of nation (Li et al., 2014). From the study done on sub humid and semi arid areas of Tanzania indicated that household size and education of the household head positively impacted net farm return from maize production. It also predicted that net revenue obtained from maize production will be negatively affected. Therefore investing in new technologies and adequate extension information services are recommended so as to increase farmer's adaptive capacity to reduce inverse effect of changing climate in maize yield and production (Valarian, 2015).

Maize yield could reduce averagely by 13.2–19.1% without adaptation and 15.6–21.8% could be reduced due to evapotranspiration during growing period at 2050s in comparison to 1961–1990. In relation with the experiment done using high-temperature sensitive varieties without adaptation, adopting adaptation of late planting, variety growing duration fixation and early

planting can averagely increase maize production by 4.1–5.6% , 9.9–15.2% and 1.0–6.0% respectively. Evapotranspiration is estimated to increase averagely by 1.9–4.4%, 1.9–3.7%, and −2.9% to −0.7%, respectively where as by using maize varieties tolerant to high temperature yield could be increase by −2.4% to −1.4%, 34.7–45.6%, and 5.7–6.1%, respectively. The research showed that larger benefits can be obtained by the development of high temperature tolerant crop varieties with high thermal requirements (Tao & Zhang, 2010).

CONCLUSION

Along with the changing climate people from all through the world are adopting different strategies to neutralize its negative effects. These strategies are found to be effected by different facts among them some are found to have positive where as some found to have negative impacts. Local knowledge of indigenous people including Chepang provides new insights into the phenomenon that has not yet been scientifically researched. So, the government should combine this perceptive with scientific climate scenario and should conduct various activities in term of adoption strategies and policies to insist targeted and marginalized farmers. Moreover, strategies to increase yield of major crops like maize need to be focused to reduce hunger and poverty.

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AUTHOR CONTRIBUTIONS

R.R.T gave the concept, provided regular guidelines and revised the article for final approval of the version to be published. P.S. and A.P.S. reviewed various articles and wrote the paper.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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