

Introduction

The food security situation in the underdeveloped country is heavily affected by the climate change effect as it has challenged the quantity of food production and its longer term stability including the effect on the food access and its utilization (Wheeler and Von Braun, 2013). Various climate change estimates have brought an increasing interest of scientific community on food and nutrition security together with the need of climate change adaptation. As number of studies are evident in studying and analyzing the impacts of climate change on crop production, yield variability in regards with food security (Fuss 2015). The increasing food demand with the rise of population has increased environmental pressures in the existing ecosystem. One of the prominent effects of human-induced climate change on the volume of food production and its quality is the governance of the food system for the equitable food distribution among the existing population (Myer *et al.* 2017). A study carried out by the Oxfam, 2011 states that Nepal is one of the world's poorest nations, with 25.2% population living below the poverty line. According to the study of the Asian Development Bank (2009) 75% of Nepal's population is under acute food shortage due to lack of food access and their weak purchasing power. People residing in the mountains experience the rise of temperature, low precipitation in winter and rising trend of natural disasters and increasing severity of insects' pests' infestation for the last twenty years. They have noted that the climate change has driven to decreased crop and livestock production and increased domestic burden to the local populations. They believe that this effect will further increase climate vulnerability in the future. However, the local populations have practiced some local climate change adaptation measures using their indigenous knowledge, such as growing improved crop varieties, improved irrigation systems and fertilizers as coping strategies (Poudel *et al.* 2017).

Objective

The paper aims to evaluate effect of climate change on food security and local adaptation mechanisms in far western hilly region of Nepal.

Methodology

The study was carried out in Badimalika Municipality of Far-Western mountainous region of Nepal. Stratified random sampling design was applied for selecting the households for questionnaire survey. The entire study area was divided into four village clusters. Sample size was determined by Arkin and Colton (1963) and 69 Households were selected for a questionnaire survey. Large number of households was taken in Martadi village because of high number of population and its marginal socio-economic and agricultural character and less influenced by the governmental and nongovernmental organizations on development interventions. Information was gathered using structured questionnaires, physical observations, Key Informant Interview (KII), Focus Group Discussions (FGDs) and literature review. The data related to rainfall and temperature was taken from Meteorological Records of Nepal published by the Department of Hydrology and Meteorology (DHM). Rainfall and temperature record from Bajura station at Kolti and Mangalsain Achham, and Chainpur Bajang was estimated using arithmetic mean method. The five year moving average method was used to find out the normal trend value for the unit of time falling at the middle of the period covered in the calculation of average.

Results and Discussions

Occupation Status

The chart below reflects the occupation status of the sampled households. It was recorded that the crop and livestock farming is the main occupation that comprise of almost 69%. It was identified that 16 % HHs were involved in services, 1 % in overseas employment and the remaining 13 % were seasonal migrants working as a labor in various sectors in the nearby cities and in India. Goats and cattle are the major livestock reared by the population for their livelihoods.

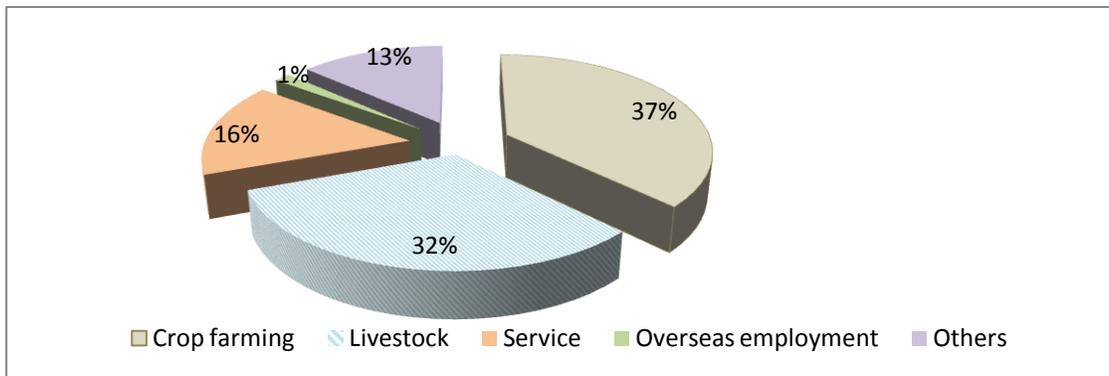


Figure 1: Occupational Status of the study area.

Household Food Sufficiency

Paddy (*Oryza Sativa*), Maize (*Zea mays*), Millet (*Eleusine Coracana*), Barley (*Hordeum Vulgare*) and Potato (*Solanum tuberosum*) being major crops of the study area, some community rear pigs, cattle, small scale poultry farm, goat etc that aid to food sufficiency mostly at subsistence level. *Figure 2* illustrates that 7% of the respondent's did not have their own farm land. 28 % had sufficient production for up to 3 months, 39% had enough food for up to 6 months, 9% had food sufficiency for up to 9 months in a year and the reaming 11% stated that their food source comes from other sectors.

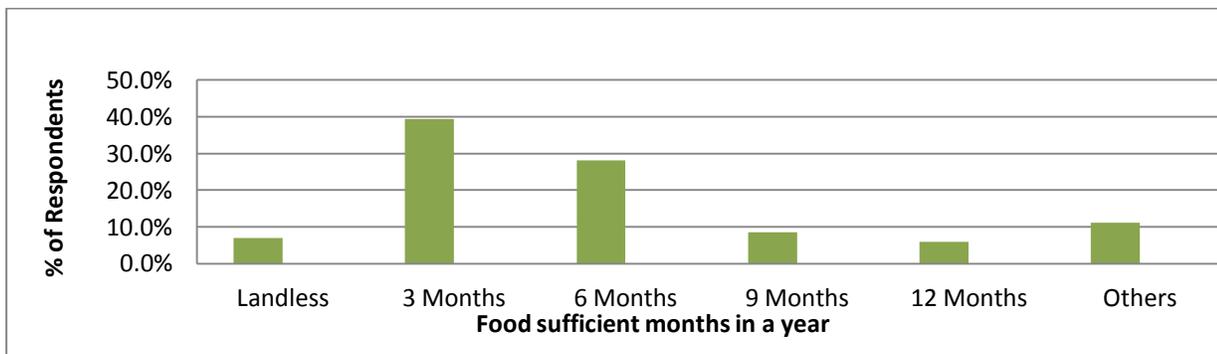


Figure 2: Food sufficiency

Rainfall and Temperature

The average annual temperature in 2017 was 15.9⁰C and was increasing by 0.06⁰C /yr. The rainfall is decreasing by 16.74mm\yr. The monsoon rainfall is decreasing by 18.75 %; Pre- monsoon by 3.51%; Post monsoon by 1.6% and winter by 6.47%.

People Perception on Temperature, Precipitation and Snowfall Pattern

45% of the respondents noted the increased temperature, 18% perceived increased precipitation while no one perceived the increased snowfall over the years. 3% perceived the decreased temperature, 39% perceived decreased precipitation and 66% perceived decreased snowfall. 24% noted no change in temperature, 18% noted no change in precipitation, and 3% perceived no change in snow fall. Unaware population on change in temperature, precipitation and snowfall were 11%, 13% and 14% respectively. 18% of the respondents stated that the temperature have been irregular over the years, 12% said the rainfall pattern is irregular over the year and 17% said the inability to predict the snowfall. The respondents did remarked that about a decade back the snow fall took place during the month of January and February periodically in alternate years, which now does not prevail in the study area.



Figure 3: People perception on Temperature, Precipitation and Snowfall

Adaptation and Mitigation Measures

Indigenous knowledge and practices and their local adaptation measures were noted during the study. Water availability for the growing crops and livestock is managed through improved irrigation system (canals). However, using variety of other improved irrigation system is still lacking. Sudden floods and other forms of natural disasters damage the infrastructures like pipelines and canals and the people have to spend a lot of time in fetching water. People built small ditches near the settlements to collect water from a spring for their household purposes.

People shortened their weeding calendar is after every 1 or 2 months of cultivation, dry leaves spreading and reaping after seed sowing, burning, offering puja at the time of cultivation and harvesting to avoid bad weather and satisfying gods and goddesses relating to harvests was also noted. Scare crow is made to keep away birds and other animals. Mulching with dry leaves and twigs is also done to retain soil moisture and cover the seeds. The wide spread use of plant indigenous materials such as ‘Titepati’ (*Artemisia vulgaris*), ‘Khiroo (*Sapium insigne*)’, ‘Angari (*Lyonia ovalifolia*)’ etc. were used to combat pests. They also used as manure mixing with dry leaves and ash.

Communities are planting trees to prevent loss of soil nutrients through surface runoff; re-claiming degraded lands by using stone dykes whereas the pastoralists during drought or dry period have been adapting through fodder collection during August, September, and October as the use of emergency fodder in winter. Agroforestry practices are complementing the fodder shortage to the smallholder farming population. Community Forestry Programs have also been showing good results in the region contributing to farmer's livelihood supplying litters, fire woods and fodders. The tree leaves cover over seedling, cultivating before rainy season, Ashuro (*Justicia adhatoda L.*) leaves cover over paddy seeds being made ready for seedling for nursery, dry leaves over millet etc. and the scare crow to keep off the birds were noted as their adaptation practices.

Some Modified techniques included plastic sheet cover over seedling, support sticks to prevent crops from falling down due to rainfall, making greenhouse to protect vegetable nursery from rainfall, cutting branch and make like home, getting new seeds from nearby cities especially from Nepaljung and Dhangadi were also detected in few locations in the study area.

Conclusion and Outlook

The government of Nepal is supplying foods in the region through National Food Corporation (NFC) in subsidized prices. However, it is not able to meet the demand of the population over the dispersed population, which has resulted to increase the seasonal migration in India and other countries in the study area. Natural disasters like seasonal floods and landslides and epidemic disease are the regular phenomena. Lack of early warning system and preparedness to disaster have worsened the situation and likely to happen the worst in near future with the changing scenario of the existing environment. Badimalika Municipality of Bajura district itself is severely food insecure as the production is not

sufficient for year round feeding of the local populations with small holder farming system. Being a mountainous district the impact of climate change is prominent which can be derived from the fact that the climatic patterns have been much more erratic and unpredictable over the years. The shifts in crop calendar and frequency of occurrence of floods, snowfall and hailstorms have further worsened the situation. Decline in crop production made the people more dependent on external aids and supports, increasing food deficit over the years. The reeling poverty and increasing dependency of households to neighboring countries even for basic requirements have been a factor of workforce depletion in the district leaving women, children and old aged people at risk of facing climatic change impacts. The monsoon rainfall is in decreasing trend but has been more erratic over the years. The duration of summer seems to be increasing as the hotter days are increasing with average temperature. The worst form of disaster has been landslide followed by drought and flood and the crop farming is most affected by all sorts of natural disasters.

Some of the few local climate change adaptation measures are: planting trees, constructing canals and stone dykes, terraces of different forms, crop rotation, inter cropping, mixed cropping, using seeds of high yielding varieties and maintaining seed storages have been into practice in their indigenous ways. Use of local plant species for pest controls, seasonal migration for surviving through the seasonal disasters, constructing greenhouses from locally available materials, practicing mulching using leaves and twigs, were also evident in the study area. However, the traditional social safety net of risk avoidance has been weakening. Evidence based policy on climate change adaptation considering the transitioned federal governance system is also a requirement to combat with the climate change effect. To that end high priority should be accorded to building drinking water system, irrigation infrastructure, improving the quality of soil. Other options include improving availability of climate friendly fertilizer and improved seeds and their use together with relevant knowledge transfer is also very important. Proven farming technologies like Sloping Agricultural Land Technology (SALT) would be one of the good technological interventions to replicate in the district. The aid support from government and stakeholders including some humanitarian organization like WFP, Oxfam, DFID, WFP among others have been unavoidable at instance together with improved logistics during transportation and storage is also equally important in the transition period and need to be supported by the government of Nepal.

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