Assessment of climate change and its impact on cash-crops in Lwang Ghalel of Kaski district

C. B. Khadka[1*], M. K. Balla[1] and K. R. Tiwari[1]

This paper focuses on climate change, its impact on cash crop production, perception of local people and their adaptation measures against the impacts of climate change in Lwang Ghalel Village Development Commitee (VDC) of Kaski district. Cash-crops such as tea, *Amriso* (broom grass) and cardamom were the main products in the study area. Primary data were collected through household survey with semi-structured questionnaires, interview with key informants, and formal and informal discussion. Thirty years meteorological data (rainfall and temperature) were collected from Narayani Basin Office, Pokhara to study the rainfall and temperature pattern. The rainfall pattern seemed to be increased at the rate of 2.74 mm per year while the mean annual maximum and minimum temperature also seemed to be increased by 0.064^0 C and 0.01^0 C per year, respectively. Tea was affected more due to climate change than other cash-crops. *Amriso* was the best adapted species against climate change due to its extended root system.

Key words: Impact assessment, climatic condition, rainfall pattern, landuse pattern, adaptation strategy

Observed data in Nepal indicates consistent warming and rise in maximum temperature at an annual rate of 0.04º – 0.06º C (MoE, 2010). High mountains are warming faster (0.08^0 C per year) than lower hills and the plains (0.04^0 C per year). This change has brought about major new challenges; its severe impact is seen on local natural resources, biodiversity and environment, leads to changes in geophysical, biological and socio-economic systems (Burton *et al.*, 2002). Various studies have shown that the impacts of climate change are evident on forests, water resources, agriculture and other sectors in Nepal. The livelihood of more than 80% local people of mountain region is heavily dependent on climate sensitive sectors such as agriculture, forest, and livestock and on the other natural resources such as water and biodiversity. They derive food, fodder, fibre, medicine, water and income from forests, grasslands and agricultural land for their livelihoods. For these reasons, Nepal is identified as highly vulnerable country to climate change (Silwal, 2009).

Nepal is richly endowed with numerous agricultural crops and plants. The variation in temporal, altitudinal, topographical aspects has made such biodiversity possible in agricultural sector (Shrestha, 2007). Cash-crops occupy 18% of the arable land. Important cash-crops include sugarcane, jute, tobacco, tea, cotton and cardamom (ABTRACO, 2008). Understanding the potential impact of climate change on agriculture in Nepal is critical for two reasons. First, the existing system of food production is highly climate sensitive because of its low level of capital and technology. Second, agriculture is the main source of livelihood for majority of the population. If agricultural production is adversely affected by climate change, the livelihoods of even greater number of people will be at risk (Dahal and Khanal, 2010).

The major cash-crops grown in Lwang Ghalel Village Development Commitee (VDC) included: tea, coffee, cardamom and *Amriso* (*Thysanolaena maxima*). These cash-crops played a significant role in the economic upliftment of the local people. The impact of climate change on production of these cash-crops should be known. Therefore, the study was carried out to assess the climate change and its impacts on agricultural crops production and to document the perception of the local people towards climate change and possible adaptation measures.

Materials and methods

Study area

The study was carried out in Lwang Ghalel VDC of Kaski district, Nepal. The study area comprises

[1]Tribhuvan University, Institute of Forestry, Pokhara
* Corresponding author: deadlock10@gmail.com

four randomly chosen wards: 1, 2, 3 and 4 of Lwang Ghalel VDC. Lwang Ghalel Conservation Area Management Committee (LGCAMC) consists of 993 households (ACA, 2009). Land-use wise, LGCAMC is covered with 72.2 km^2 of forest, 5.5 km^2 of shrub-land, 25.3 km^2 of grass-land, 10.2 km^2 of agricultural-land, and 37.1 km^2 of barren-land, 2 km^2 of sand-gravel-land, 12.6 km^2 of glacier-land without ponds and snow, and 0.2 km^2 of river (NTNC, 2009).

Data collection

With the sampling intensity of 23%, a total of 101 households from the selected wards: 1, 2, 3 and 4 were chosen for the household survey. The respondents included 76 males and 25 females. Required information and data were solicited through reconnaissance survey, key informant interview, formal and informal discussion, and direct observation. The rainfall and temperature data recorded up to the period of 1977 to 2009 in the nearest meteorological stations; Ghandruk, Lumle and Siklesh were obtained from the Narayani Basin Office, Pokhara. They were analysed using the MS-Excel to determine rainfall and temperature trend, and regression. The information obtained from the questionnaire was analysed by using SPSS software. Land-use map was used for the interpretation of the agricultural land-use (NTNC, 2009).

Results and discussion

The majority of the respondents were Gurungs (32.7 %). About 66 % were literate while the rest were illiterate. The main occupation of the majority (83.2%) of respondents was agriculture.

Rainfall analysis

Lumle, which lies at the southern part of ACA, has observed an increasing trend in annual precipitation with increases in winter, post-monsoon, pre-monsoon and monsoon seasons by 4.3 mm, 32.7 mm, 48 mm and 205 mm per decade, respectively. Siklesh, on the other hand, has shown a decreasing trend in annual precipitation by 125 mm per decade. Ghandruk also showed tremendous decreasing trend of average annual rainfall with the rate of declination of nearly 333 mm per decade. The trend analysis based on annual rainfall record (1977–2007) at these stations revealed that Lumle followed an increasing trend of rainfall whereas Sikles and Ghandruk followed the negative trend (Pandit, 2009). The linear trend line of average mean annual rainfall of the nearest stations: Ghandruk, Lumle and Siklesh (1977–2009) indicated that rainfall pattern had increased at the rate of 2.74 mm per year (Fig. 1).

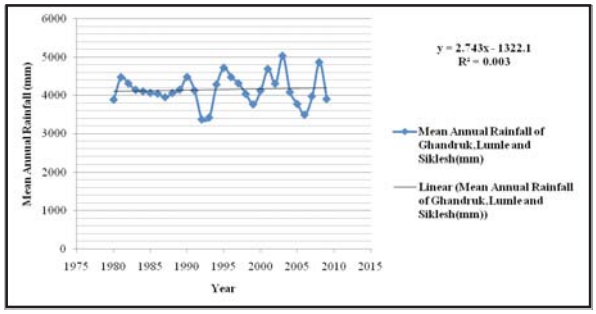

Fig 1: Mean Annual Rainfall trend at Ghandruk, Lumle and Siklesh Station (DHM, 1977–2009)

Temperature analysis

The trend of temperature increase at Lumle was much higher in winter as compared to other seasons. The linear trend line (Fig. 2) showed that mean annual maximum temperature and mean annual minimum temperature at Lumle have increased by 0.064^0 C and 0.01^0 C per year, respectively. This increase in temperature has supported the evidence of climate change. The temperature trend line of winter follows the steeper path making the difference of nearly 3.7^0 C during an interval of 30 years resulting in an average rate of 1.1^0 C per decade, while the other seasons show trend of 0.33^0 C per decade (Pandit, 2009).

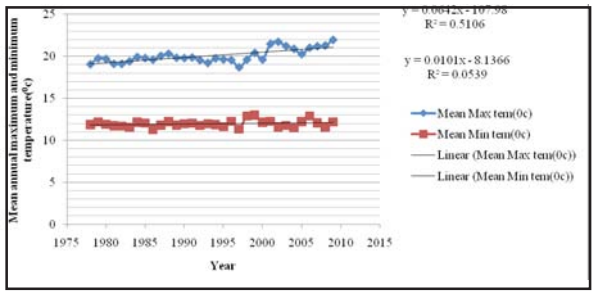

Fig: 3 Mean annual maximum and minimum temperature at Lumle Station (DHM, 1977-2009)

Knowledge and perception on climate change

According to 55% respondents, the major source of information about the climate change for them was media (extension) like radio, television and newspapers. However, 39 % reported that they knew about climate change through their own experiences.

It was found that the major cash-crops grown by the majority of respondents (45.5%) were tea followed by *Amriso* (17.8%) and both tea and *Amriso* (7.9%). According to the majority of respondents i.e. 36.6%, the main reason for change in flowering, fruiting and harvesting time of cash-crops was snowfall. Tea was the most affected cash-crop by snowfall.

Gandhe Jhar (*Ageratum conizoides)* was the major new species found in the farm land as reported by 62.4% respondents. 13.9% reported Banmara (*Eupatorium adenophorum*) and 14.9% reported both species as new species in the farm land. These tropical species are indicator of climate change since they are found in hotter areas. Since some of the cash-crops like tea, and coffee are grown in small areas in farmland, these species affected the growth of cash-crops. According to 47% respondents the major source of water supply was forest streams, followed by water tanks (33%) and rainfall (20%). Soil moisture has decreased in the study area.

It was found that tea was grown in 11.2 ha with the annual production of 9,342 kg, *Amriso* in 9.25 ha with 31,240 brooms and cardamom in 1.25 ha with 125 kg. The decrease in cash-crops has been reported in the area and the reasons are shown in figure 3. The major reasons for decrease in annual production of cash-crops as reported by 37.6% respondents were defective seedlings, lack of knowledge of planting and drought followed by combined effects of decrease in leaf and root and snowfall (10.9%).

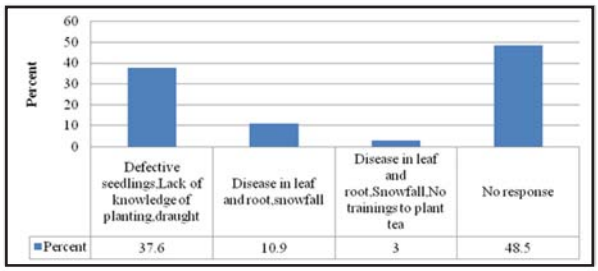

Fig 3: Reasons for decrease in production of cash-crops annually

Impact assessment and adaptation strategies

Climate change impacts, their adaptation strategies and measures are illustrated in table 1. The construction of dam, plantation and terrace cultivation were done as adaptation measures against soil erosion and landslide. Similarly, conserving forest streams and provision of water tanks were done to conserve the water sources in the study area. Use of farm yard manure (FYM), *in situ* manuring, use of compost and pesticides were the measures adopted to improve the soil fertility of farmland.

Table 1: Impacts, adaptation strategies and measures

Impacts	Adaptation Strategies	Measures
Soil erosion / landslide	Soil conservation activities	Construction of dam, plantation, terrace cultivation
Water sources	Water resource conservation	Conserving forest provision of water tanks
Farmland fertility	Soil fertility management	Use of farm yard manure, *in-situ* manure, compost, pesticides

Study shows that due to climate change, tea was more affected than cardamom and coffee. Out of 50% respondents that responded 24% respondents reported that tea was affected more from climate change than *Amriso* (19%), cardamom (6%) and coffee (1%). According to 65% respondents, *Amriso* was the best adapted cash-crops against the climate change because of its extended roots while only 22% reported tea as the adapted species.

Conclusion

It was found that the rainfall pattern in the study area was irregular. There was increase in both mean annual maximum and minimum temperatures. The appearance of invasive tropical weeds like Banmara and Gandhe Jhar in the farm land implied shifting of vegetation from temperate to tropical, thus indicated temperature rise in the study area. Snow-fall was the main reason for changes in flowering, fruiting and harvesting time of cash-crops. Defective seedlings, drought and lack of planting knowledge were responsible for declining cash-crops. Since tea was grown in larger area, it was affected more than other principal cash-crops like *Amriso* and cardamom. The best adapted species from the climate change perspective was *Amriso.* The plant has extended roots and, therefore, can absorb moisture from soil even in drier conditions. People also prefer *Amriso* to other cash-crops as it has shorter rotation period and as it provides benefit within a year.

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