Project Report

PROSPECTS OF CROP PRODUCTION IN MOUNTAINOUS AGROECOSYSTEM OF GILGIT-BALTISTAN UNDER CHANGING CLIMATE

Submitted by

Prof. Dr. Syed Muazzam Nizami

Principal Investigator

Integrated Mountain Area Research Center (IMARC)

Karakoram International University

Gilgit

2018-19

SUMMARY

Crop production in temprate environment is highly dynamic and vulnerable to climate change. The major cash and food crops in Gilgit-Baltistan region of Pakistan are potatoes, maize, wheat. These crops have been emerged as source the most promising commodities for livelihood of the inhabitants. Production rates of these commodities vary significantly in different valleys of districts of Gilgit-Baltistan. This study has been designed to investigate the impact of climate change on production of potato, maize and wheat in three districts namely Hunza, Gilgit and Shigar of Gilgit-Baltistan. These districts are predominantly vulnerable to GLOF or other natural disasters under changing climatic conditions. Fifty respondents (farmers) were randomly selected from the GLOF or natural disaster prone communities in each of the aforementioned districts. A pre-developed questionnaire was used to gather information about area of production per hectare of each crop for five years from 2014 to 2018. Face to face interviews were conducted while visiting the communities in year 2018-19. The metrological data were collected from nearby metrological station as well as from Pakistan Meteorological Department (PMD). The relationship between production rate, area of cultivation and changing climate was developed to determine effect of climate change on production of potato, maize and wheat in Gilgit-Baltistan. From research results it can be concluded that climatic factors in the study area have correlation with production rate of crops.

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CHAPTER 1

INTRODUCTION

Agriculture plays a central and strategic role in Gilgit-Baltistan's economic development. Indeed, it has a pivotal role in household income, improved living standards and augment of food security. The area, production and utilization of cereals in Gilgit-Baltistan differ within the districts but the agricultural practices i.e., sowing, watering, weeding, harvesting, and threshing are performed in similar ways. The cropping patterns in Gilgit-Baltistan have been developed over the centuries to address population's primary need of food security. Farmers grow mix crops on available land which includes cereals, fodders, vegetables and fruits. The season of the cropping depends on the agro-ecological zones included as; double cropping zone, marginal double cropping zone or single cropping zone.

Potato is one of the major cash crops that is being grown in all major agro-ecological zones of Gilgit-Baltistan. It is a major global crop that has an important role to play in food security, reducing poverty and improving human nutrition (George et al., 2017). Potato production has dramatically increased in developing countries in the past two decades (Brich et al., 2012). Over the years, people of Gilgit-Baltistan tried to increase the production of potatoes and for that they practiced much adaptation such as use of artificial fertilizers and crop rotation etc. But there is dynamic of potato production influenced by climatic changes in different areas of Gilgit-Baltistan. Because of erratic rainfall patterns, heavy sown fall, heat waves, and droughts and flooding, it leads to change in the production

rates of potato each year. The changing climatic conditions of an area have great influence on crop production.

Climate change involves complex interactions between environment and agriculture. It causes many seasonal variations in temperature of the world due to increase in the concentration of climatic related greenhouse gases. Within south Asia, Pakistan is considered the most vulnerable economy to climate change (Ahmed et al., 2016).

Pakistan is also becoming increasingly vulnerable to climate change. There are many areas in GB, which are potentially vulnerable to climate change and many communities are scattered under the glaciers. Expectations of crop failure is as high with rising temperature and variable rainfalls. This is because global warming negatively impacts the tropical and arid crop production, although it enhances agricultural production in temperate regions in the short term (Ahmed et al., 2016). Due to climate change, rate of potato production in a few areas of Gilgit-Baltistan has been increased while there is a decline of production rates in rest of the areas. Alternatively, melting of glaciers due to climate change also has increased the floods and led to destruction of cultivated lands.

As reported climate change has potential impact on crop production through reducing acreage suitable for cultivation, shifting duration of growing season, affecting yield potential, enhancing severity and frequency of droughts and floods and augmenting chances of plant diseases (World Bank, 2013).

This study explores the dynamics in production of certain crops including potatoes, wheat and maize due to climatic changes because it has direct impact on agriculture. Likewise, it is also very important to have good crop production rates to increase food security and economic development of the region. This study will give a detail view about influence of climate changes on the crops, especially potatoes, wheat and maize and its production dynamics over the last five years. Furthermore, this will help to recommend different adaptations to reduce the food security risks and livelihood protection for upcoming years. To address the challenges of climate change and to design appropriate adaptation strategies, it is very important to have some ground realities. This hidden information can only be extracted by taking consideration of indigenous knowledge and experience of inhabitant communities, who are living near the vulnerability context and are able to cope with extreme weather and environmental changes over the centuries. Therefore, main objective of this study was to gather perceptions of local communities and to find out the ground realities of adaptations towards the climate change.

CHAPTER 2

METHODOLOGY

2.1 Research Design

This study is based on primary data collected in July and August 2018 from farming communities residing in different valleys of Gilgit-Baltistan region of Pakistan. A pre-developed questionnaire was used, which included data pertaining to local perception on production dynamics with climatic changes and the productivity in last five years.

2.2 Study Sites

This study focused on such farming communities of Gilgit-Baltistan which were residing near glaciers and were highly vulnerable to Glacial Lake Outburst Floods (GLOFs). These communities are involved in farming. Due to climatic changes these communities experience variation in the productivity of their farms due to changes in climate. The main glaciers included in the study areas are Shimshal, Bagorot and Abruzzi. Under these glaciers, communities scatter in valleys called Bagrot in district Gilgit, Pasu in district Hunza and Shiger in district Shiger.

2.3 Climatic Conditions

Temperature and rainfall variations during last five years are presented in Figure 1 for district Gilgit, in Figure 2 for district Hunza and in Figure 3 for district Shiger. From 2014 to 2018 minimum and maximum temperature gradually increased at each site. Moreover,

temperature varied among the sites and among the years. District Gilgit is hotter compared to Hunza and Shigar. Diverse pattern of rainfall has been observed at each of study sites. District Gilgit and Hunza mostly received the greater amount of rainfall compared to district Shiger.

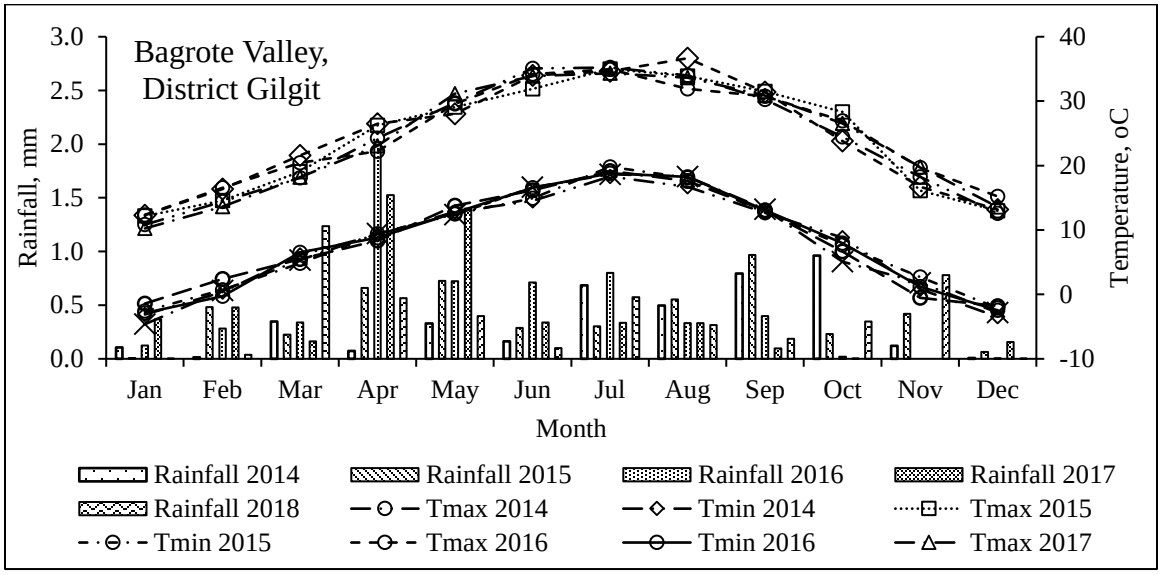

Figure 1 Temperature and rainfall variations round the year from 2014 to 2018 in District Gilgit

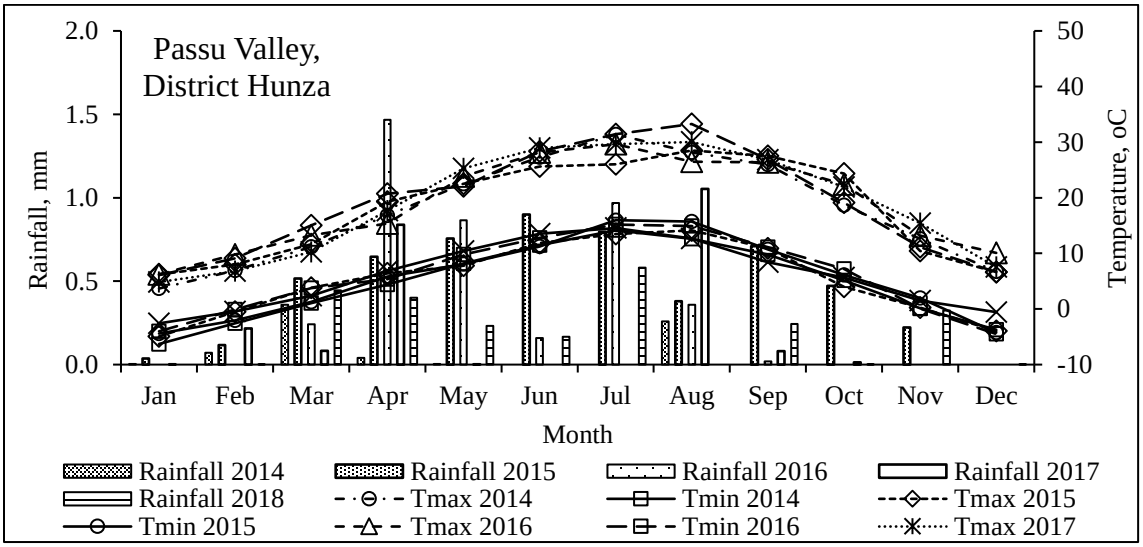

Figure 2 Temperature and rainfall variations round the year from 2014 to 2018 in District Hunza

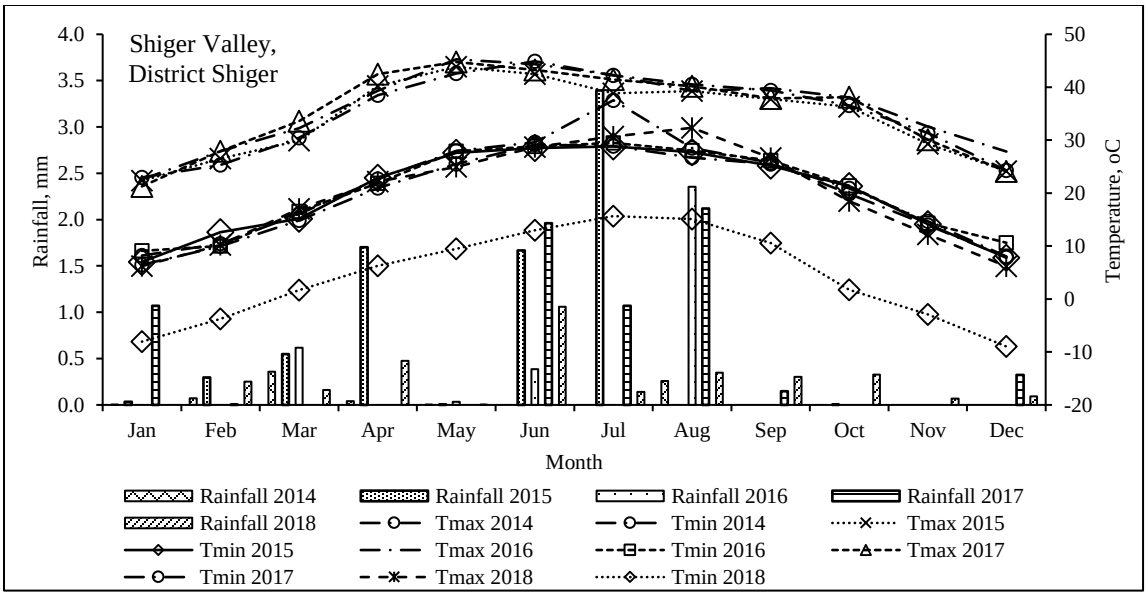

Figure 3 Temperature and rainfall variations round the year from 2014 to 2018 in District Shiger

2.3 Sampling Strategy

A sample population of three villages from three mountainous districts which are more vulnerable to GLOFs and other natural hazards were selected. From these three villages, fifty respondents from each of the villages were selected randomly. Information from these farmers regarding their perceptions about dynamics in production due to climatic changes was recorded through questionnaire. Both knowledgeable men and women were involved in the personal interviews in order to collect the information related to crop productivity and it's dynamic within last five years. Specifically, data pertaining to rate of crop production and area of cultivation were asked from each peasant for the last five years.

2.4 Data Analysis

Survey data were statistically analyzed for descriptive statistics and research results were presented in the form of tables and graphs and interpreted. Relationship between climatic factors and crop production rates was described.

CHAPTER 3

RESULTS

3.2 Climate change impact on crop production

Climatic variation and production rate of potato, maize and wheat at Bagrote valley of district Gilgit for year 2014 to 2018 are presented in Figure 4. At Bagrote valley, during Rabi season minimum and maximum temperature was in the range of 8.5 to 9.2 ^{o}C and 24 to 25.3 ^{o}C while the rainfall was 0.2 to 0.8 mm. During Kharif season, minimum and maximum temperature was 31 to 32 and 13.8 to 14.6 and rainfall was 0.2 to 0.7 mm. Production rate was in the range of 3.2 to 5.6, 1.5 to 4.5 and 3.4 to 4.6 t ha^{-1} for potato, maize and wheat, respectively. Production rate of potato and wheat was positively correlated with temperature and rainfall fluctuations of Rabi season while that of maize was positively correlate with maximum temperature but negatively correlated with minimum temperature and rainfall pattern during its cropping season of Kharif.

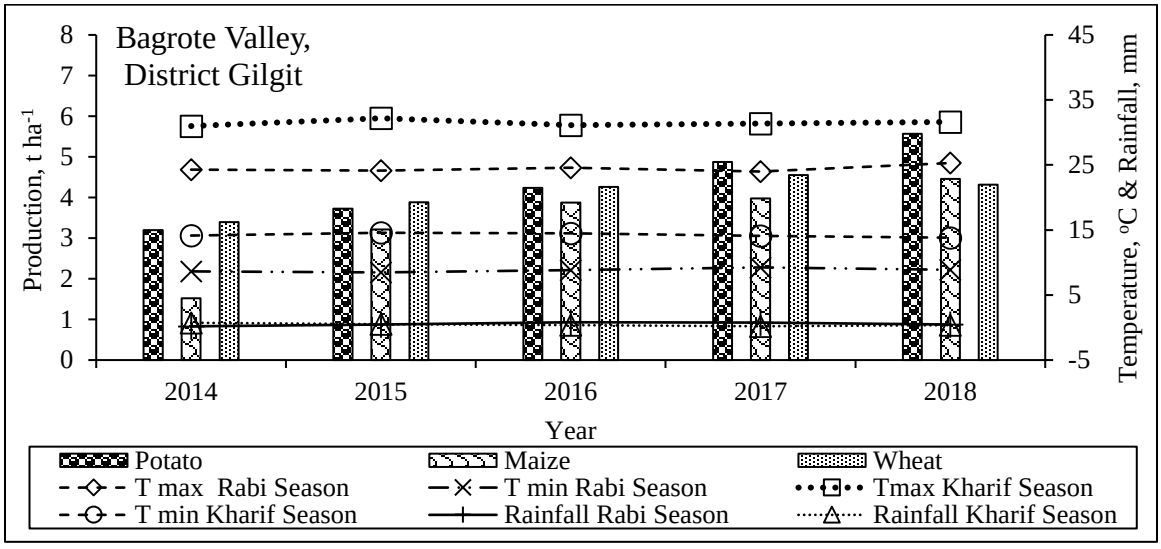

Figure 4 Effect of climate change on production rate of potato, maize and wheat at Bagrote valley in District Gilgit

Variations of temperature, rainfall and production rate of potato, wheat and maize from 2014 to 2018 at Passu valley of district Hunza are presented in Figure 5. Maximum and minimum temperature at this site was in the range of 17.0 to 19.0 and 4.5 to 6.6 ^{o}C during Rabi season while 23.4 to 24.8 ^{o}C and 8.4 to 10.1 ^{o}C during Kharif season, respectively. In the valley, rainfall varies from 0.23 to 0.60 and 0.23 to 0.78 mm in Rabi and Kharif seasons, respectively. Production rate of potato, maize and wheat varied from 3.2 to 5.6, 1.5 to 4.5 and 3.4 to 4.6 t ha^{-1}, respectively. In Passu valley, production rate of potato, maize and wheat was positively correlated with temperature but negatively correlated with rainfall of respective cropping season.

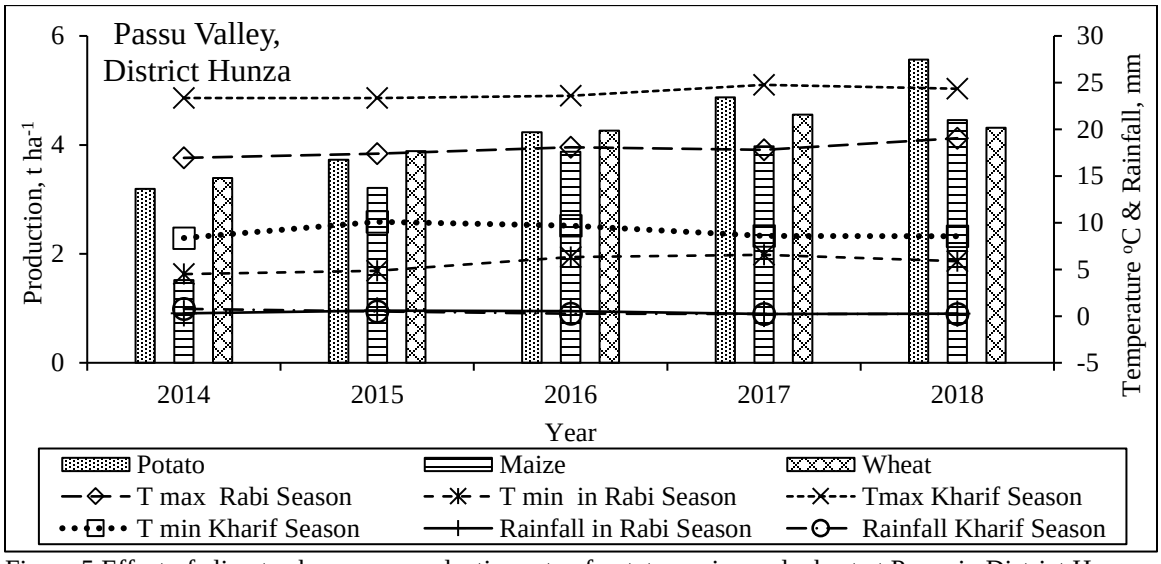

Figure 5 Effect of climate change on production rate of potato, maize and wheat at Passu in District Hunza

At Shiger valley, dynamics of climatic factors and associated changes in production rate of potato, maize and wheat from 2014 to 2018 were presented in Figure 6. Ranges of maximum temperature, minimum temperature and rainfall during five years' period varied

from 20.6 to 38.4 ^{o}C, 5.34 to 21.4 ^{o}C and 0.1 to 0.84 mm in Rabi season while 24.1 to 38.4 ^{o}C, 8.04 to 25.12 ^{o}C and 0.1 to 0.7 mm in Kharif season, respectively. During this period production rate of potato, maize and wheat were varied from 3.2 to 5.6 t ha^{-1}, 1.5 to 4.5 t ha^{-1} and 3.4 to 4.6 t ha^{-1}, respectively. Production rate of all the three crops was negatively correlated with minimum and maximum temperature but positively correlated with rainfall.

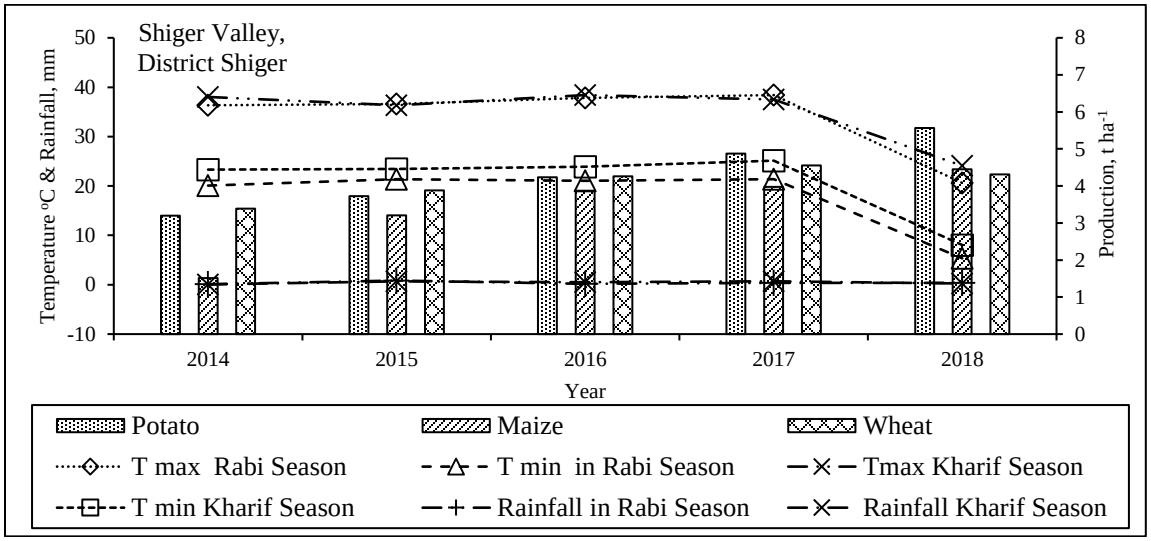

Figure 6 Effect of climate change on production rate of potato, maize and wheat at Shiger Valley in District Shiger

Table 1 Relationship between production rate of potato, maize and wheat with climatic factors at Bagrote, Passu and Shiger valleys through coefficient of correlation (r)

Site	Crop	Rabi Season			Kharif Season		
		T max	T min	Rainfall	T max	T min	Rainfall
Bagrote	Potato	0.59	0.67	0.47	0.16	-0.59	-0.81
	Maize	0.43	0.56	0.73	0.34	-0.17	-0.89
	Wheat	0.18	0.79	0.86	0.14	-0.17	-0.99
Passu	Potato	0.92	0.74	-0.46	0.84	-0.27	-0.88
	Maize	0.86	0.82	-0.04	0.67	0.16	-0.97
	Wheat	0.70	0.95	-0.18	0.81	0.03	-0.98
Shiger	Potato	-0.67	-0.71	0.08	-0.73	-0.68	0.16
	Maize	-0.43	-0.45	0.29	-0.52	-0.45	0.49
	Wheat	-0.18	-0.23	0.16	-0.28	-0.20	0.58

CHAPTER 4

DISCUSSION

Due to different climatic conditions and disastrous events in the form of rainfall and floods in the study area, production rate of crops was varied. The yearly changes in production rates in these regions were due to changes in climate and associated factors. So the production rates of crops in these regions varied where the temperature varied. Farmers characteristics including their gender, age and qualification helped them to fight against adverse environmental changes. Farmers with higher qualification are engaged in government and non-government jobs while farmers of lower qualification were less awareness about crop production. Hence farmers having qualification of middle and matric were more successful in study area to have more cultivation area as well as production rate of crops. Shiger is the coolest among these three regions and hence the production rate of crops at Shiger was increasing with increasing. At Pasu valley, production rate was also increased but at Bagarot location production of potato was decreased because this is not much cooler area as compared to other two regions. Potatoes required cool frost free growing season. Hot weather reduces the number of tubers per plant. The ideal temperature for growing potato is 45^{o} to 80^{o} F. Thus, the production of potatoes is decreasing where the temperature is increasing beyond the range for the potato cultivation.

Effect of yearly change of climatic parameters coupled with disastrous events on crop productivity of wheat at Bagrot, Passu and Shiger valleys were assessed. This study showed

that the production of wheat was increased at certain locations as the yearly temperature increased. As global temperature is increasing day by day and this risen in temperature is beneficial for wheat production in some region where optimum temperature is existed for wheat production.in GB. Bagrot valley had higher production rates of wheat than Passu and Shiger because Bagrot is much warmer than the Shiger and Passu. Although Passu has higher land area for wheat production due to climatic condition, the production rates are less than Bagrot. While Bagrote's climatic conditions are suitable for wheat production. The production rates will increase in coming years. Wheat is used as food in Gilgit Baltistan because production is less than its demand. People are needed to take improvement in the production but climatic conditions can cause food security problems in the mountainous area. Furthermore, the area which are not suitable for the production of wheat like Passu and Shiger, farmers are needed to move on to the another crop like potato and maize or took changes in other practice of agriculture like change the sowing of seeds according to their climate and adaptation scenarios and management strategies to climate change that maintain or increase yields while minimizing the effect of climate change.

Results indicate that there is a decline pattern of maize yield in all three study regions of Gilgit Baltistan according to the cultivated area. Rise in temperature and heavy rainfall both have negative impact on maize yield that's why people lessen the trend of maize cultivation in GB. But availability of water due to glaciers melting have somehow positive response to maize yield. Decline of maize yield in Shigar valley is due to degradation of area under cultivation through flooding. This region is most vulnerable to GLOF. There is

a need of timely preparation and adaptation to climate change, raising awareness among maize farmers on climate change and forest cover may increase for CO_2. High temperature increase the growth rate of maize and reduce the kernel filling which leads to reduce grain formation. Increase temperature may reduce the rate of photosynthesis, pollen viability, seed abortion and less seed setting which ultimately reduce the grain yield. Increase in maximum and minimum temperature cause shorting the duration of flowering and maturity (Ishfaq et al., 2018). Gilgit Baltistan agriculture sector and policy makers should focus investments on infrastructure development i.e. biological and engineering interventions to handle the extreme disaster events.

CONCULSIONS

This study analyzed the effect of yearly changing climate at different sites and production of potato, maize and wheat in Gilgit-Baltistan. The results showed that production rates in some regions of GB are increasing with increase in temperature. Because the region like shiger and pasu were very cool and the forst condition were too long, as the temperature increases due to climatic change, the frost condition become less that cause to risen in production of potaoes. While the climatic condition were not that much frost but suitable for cultivation in Bagarot and these condition are becoming hot and hot each year, which lead to deceares in production of potatoes. The land use for the potato cultivation is very less in Shiger, which should be increased in up coming years because the climatic conditions are good and within the range for potato cultivation. This cash crop can be suitable for livlihoods of Shiger and Pasu. Though, the area for potato cultivation is high in Pasu but the local people needed to pay more attention for better production rates in up coming years by using morden and feasible methods of potato cultivation. On the other hand, the production rates of crops are decreasing in Bagarot because the climate is increasing year by year and it goes beyound the range for cultvation, so the local people needed to grow another optional crops according to the temperature or they should change the timing of cultivation in the region.

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