

## Research Article



# Climate Change and Agriculture: An Overview of Farmers Perception and Adaptations in Balambat Tehsil, District Dir Lower, Pakistan

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**Abstract** | The present research was aimed to determine the ability of farmers to detect climate change and how they have adapted to whatever climate change they believe has occurred. Farmers have indigenous knowledge of the climate of the area to predict and forecast the changing weather and climate. Knowing such traditional knowledge provides an opportunity to understand how the farmers are adapting to new type of weather. The study was carried out in Balambat Tehsil District Dir Lower. They study is primarily based on questionnaire survey and focus group discussion. A total of fifteen villages out of total 173 were selected for study, 75 farmers were interviewed, 05 from each of the 15 selected villages. A total of 15 focus group discussions were organised, one is each selected village. The key parameters addressed during survey were cropping pattern, sowing, harvesting date and yield per acre of different crops, pests and crops diseases, flowering time of fruits trees, biodiversity and livestock's. Respondents were selected randomly but priority was given to elders and those possess land and practice agriculture. The study reveals that majority of the respondents are well aware of climate change and its effects on cropping calendar, crop variety, crop yield, crop diseases as well as an earlier blossoming of fruit trees. The respondents in all the fifteen villages unanimously agreed that sowing and harvesting dates of crops are 10-20 days earlier than it used to be 20 year ago (1992-2012). Similar change was reported in the time of fruit tree blossoming because of the onset of early summer and shortening of winter season. Majority of farmers believe that warmer climate caused a variety of new crop diseases. Survey reveals that there is not only decrease in the amount of rainfall but the timing of rainfall is also changed. The study demonstrated mixed type of results about the awareness level of the respondents in relation to climate change. The only adaptation strategy opted by farmers in the study area is change in crop calendar.

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## Introduction

In Pakistan the climate change research is mainly focused on biological and physical aspects of climate change. Recently a couple of researches carried out by IUCN in Gilgit Baltistan studied community perception to climate change. Most of the agrarian researchers agreed that change in the temperature

and precipitation (high temperature and low precipitation) will lead change in the cropping pattern, land use and availability of water for irrigation. Fluctuation in these elements of weather and climate will adversely affect the agriculture productions (IUCN, 2008).

The vulnerability of agriculture to both climate

change and variability of weather is well documented fact. Scientific community is agreed that variability in the elements of weather specifically temperature and precipitation will result a changing land use and cropping pattern. Besides the water deficiency will consequently reduce agriculture productivity and vulnerable areas are expected to experience a decline in crops yields (IPCC, 1996; Murdiyarso, 2000; IPCC, 2001; Rosenzweig et al., 2002).

Despite impressive technological advancement in agriculture sector, the agriculture production to a larger extent is still dependent on weather and climate (Adetunji et al., 2005). Studies of potential vulnerability of crops to heat stress under a climate change scenario of 0.3°C per decade determine that all the selected crops suffered from heat stress. Crops like wheat, cotton and sugarcane were more vulnerable to heat stress as compared to other crops (GoP, 2003).

The study of climate change impact on agriculture has becoming a subject of increasing importance, (Lu et al., 2011). In most of the developing countries of the world the limited knowledge about climate change and its impact on agriculture, affecting the sustainable development (Kemausuor et al., 2011). Pakistan is long being considered as agrarian economy but its share in GDP is decreasing from 24% in 2009, to 21.8% in 2011 (Siddique et al., 2012). Pakistan agriculture will have to face an unprecedented challenge in the next century. Unfortunately climate change research in Pakistan is mainly concentrated on physical and biological indicators. Very little work is done on community/farmer's perception of climate change. The present research is aimed at assessment of farmer's perception and response to climate change in Balambat tehsil, district Dir Lower. The research attempts to investigate how changes in weather and climate are perceived by farmer's communities, how the change in temperature and precipitation have affected the agriculture sector of the area and in turn the lives and livelihood of the local population. Last but not the least how farmers are coping with and adapting to climate change. The objectives of the study were:

- To analyze how the climate change was comprehended by local farmers.
- To assess how changes in temperature and precipitation have affected the agriculture, lives and subsistence of the local population.
- To determine how farmers were dealing with and

adapting to the changing pattern of temperature and precipitation.

## Materials and Methods

### *Research design and instrument*

The study is mainly based on primary sources of information. Extensive fieldwork was carried out for the collection of data through a semi-structured questionnaire. The questionnaire includes questions on different aspects of climate change and its impact on agriculture. The variables addressed in the questionnaire included crop calendar, crop yield, fruit tree flowering and crop diseases etc.

### *Universe and sampling*

There are 173 villages in the Balambat tehsil. The study focused on 15 villages, selected through purposive sampling. Priority was given to those who were easily accessible and having agricultural land (Figure 1). Being focused on temporal variations of climate, age factor was considered for the selection of respondents. Elders aging above sixty years were given priority in order to have a deeper understanding. As this is a case study with a pre-defined focus, five respondents have been interviewed from each sampled village. A total of 75 questionnaires were filled which make the overall sample size which is 3% of total household of study area. In order to ensure a high degree of inter subjectivity, questionnaire survey was followed by focus group discussion, done in each village to determine the perception of the farmers on climate change, and to verify the results of questionnaire survey. Fifteen FGDs (Focus group discussions) were carried out, one in each selected village.

The major constraint of the study was the temporal scale associated with the research, the individual perception of climate change are vague and are sometime not related to climate change. In addition, human perception of climate is strongly influenced by expectations. The research is based on answer provided by farmers and not on climatic data. (Table 1)(Figure 1)

## Results and Discussion

### *Change in crops calendar (Time of crops sowing and harvesting)*

Fluctuations in temperature and precipitation result in the shifting of crop calendar. The majority of the respondents were of the opinion that the sowing and

harvesting dates of crops have shifted and taking place earlier. Nevertheless there was some difference of opinion on the number of days by which the sowing and harvesting time has changed. Majority of the farmers surveyed reported a shift of about 10-14 days. **Table 2** summarised the survey results. The change in crop calendar was attributed to the spatial and temporal variation in the pattern of rain and temperature. Some of the respondents stated that even the seeds which they were using in the past are no more effective in the changing climatic conditions.

**Table 1:** Name of sampled villages and there population characteristics 1998.

S. No	Name of Village	Population	Literacy ratio	No. of Household	Average Household Size
1	Koto	4,014	30.8	431	9.3
2	MalakandPayeen	3,025	42.9	299	10.1
3	Munjai	3,014	48.2	363	8.3
4	Baroon	2,345	41.6	254	9.2
5	Haji Abad	1,834	52.1	206	8.9
6	Rehankot	1,822	16.7	182	10.0
7	Malakandbala	1,512	32.4	169	8.9
8	Manogai	1,273	22.8	141	9.0
9	Safry	1,124	33.3	108	10.4
10	Moranai	1,111	50.0	94	11.7
11	Anwer Abad	1,102	18.0	118	9.3
12	Shera	733	40.1	71	10.3
13	Mano Khwar	641	53.6	72	8.8
14	Tangi	219	22.3	21	10.4
15	GhloTangi	180	37.8	14	12.9

Source: GoP, 1998.

**Table 2:** Balambat Tehsil: Change in Sowing Time (Number of Days) of Different Crops (1992 to 2012).

Name of crops	Sample size	20 years ago (1992)	Present (2012)	Average change (Days)	Standard Deviation
Rice	75	17-June	3-June	-14	0.85
Wheat	75	28-December	15-Decem-ber	-13	0.79
Okra	75	31-March	14-April	+13	0.79
Spinach	75	13-August	3-August	+09	0.83
Garlic	75	5-November	25-October	+10	0.63
Onion	75	14-October	25-October	+11	0.67

Source: Field Survey.

Similarly the response regarding harvesting time of various crops also diverse, however majority of the re-

spondents reported 7-15 days shift in the harvesting. The results are shown in **Table 3**.

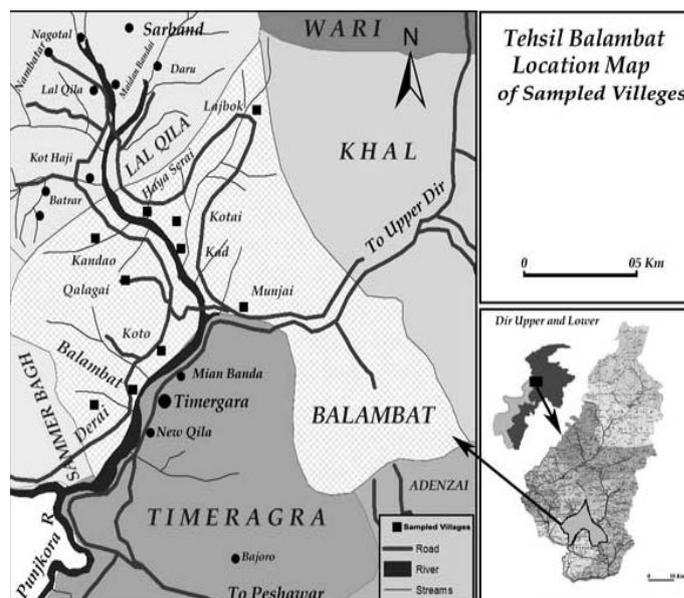


Figure 1: Location of sampled villages.

### Change in crop yield

According to **Gregory et al. (1999)** wheat and rice crops indicated reduction in yield per hectare as a consequence of climate change (warming). The experiments carried out in northern and central Italy demonstrated that under current crop management practices, the climate change would decrease crop yields by 10-40% mainly because the warmer air temperature. The experiments also suggested that 60-90% more irrigation water will be needed to maintain grain yield under climate change scenario (**Tubiello et al., 2000**). However in the study area, survey results suggest that yield per hectare increased. This increase in yield was attributed to the adaption of high yielding varieties (HYV) of crops, introduction of improved irrigation facilities, mechanization of agriculture and increasing use of chemical fertilizers. (**Table 4**).

### Pests and diseases

One of the possible consequences of global warming and climate change is the effect on the distribution of pests and microorganisms. The scientists have sufficient evidence for the effect of climate change on many biological systems (**Woods et al., 2005; Elphinstone and Toth, 2008**). Studies indicate that pests and crop diseases will likely to increase under climate change, leading to greater risk of crop failure and crop loss (**Rosenzweig and Hillel, 1998; Patterson et al., 1999; Gutierrez, 2000**).

**Table 3:** Balambat Tehsil: Change in harvesting time (number of days) of different crops (1992 to 2012).

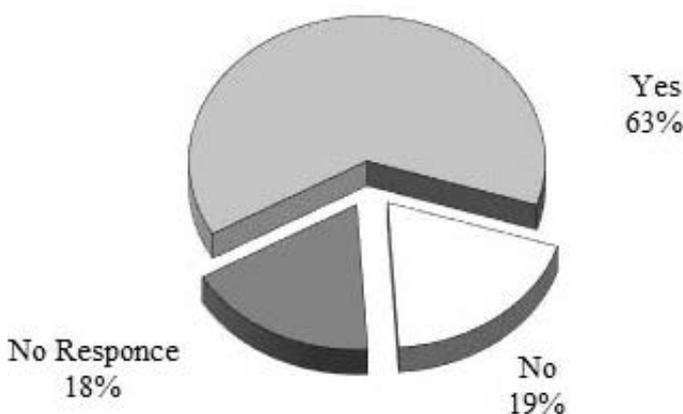
Name of crops	Sample size	20 years ago (1992)	Present (2012)	Average change (Days)	Standard Deviation
Rice	75	17-September	3-September	-14	0.70
Wheat	75	17-May	7-May	-10	0.83
Okra	75	4-October	25-September	-09	0.65
Spinach	75	24-August	3-September	+11	0.56
Garlic	75	4-May	27-April	-07	0.81
Onion	75	28-June	21-June	-07	0.75

Source: Field Survey.

**Table 4:** Balambat Tehsil: Annual increase in crops production kg. per hectares (1992- 2012).

Name of Crops	Sample size	Increase in yield Kg/Hectares	Standard Deviation
Rice	75	640	86.4
Wheat	75	804	108.5
Okra	75	1200	146.8
Garlic	75	704	80.6
Onion	75	1380	133.5

Source: Field Survey.



**Figure 2:** Increase in the crops diseases and pests 1992 to 2012.

The present study records a vague response regarding impact of climate change on crop diseases and pests therefore, the results are inconclusive. This wispy response may be due to the fact that agriculture in the study area has significantly changes during last 20 years, not only because of global warming /climate change but also because of increasing mechanization of agriculture. Hence it seem difficult for respondents to link crop diseases and incidence of pests to any causative factors. However majority of farmers were of the opinion that warmer climate is favourable for pests and crop diseases. Rust was reported as the most prevailing disease of the study area. Survey results are summarised in Figure 2.

*Change in crop selection*

Crop selection is often considered as a possible adaptation strategy to climate change, which is based on several factors, i.e. inputs such as labour, seed availability, fertilizers, market prices, government policies and a number of social and environmental factors such as climate, soil condition and irrigation water availability etc. (Kurukulasuriya and Mendelsohn, 2006).

The present research reveals that almost no change has occurred in the selection of crops varieties. However, the availability of high yielding seed varieties and chemical fertilizers has transformed the local agricultural practice to some extent. Previously farmers used to practice subsistence farming to ensure self-sufficiency, but today there is less crop diversity. Farmers mostly grow one or two crops like wheat, onion and rice etc. and rely on the market for vegetables.

*Change in water availability for agriculture*

According to the respondents, rainfall used to be the major source of irrigation in the past; however, currently other sources of irrigation such as canal and tube wells have also been introduced. According to survey results, 60% respondent practice canal irrigation while 22% rely on tube well for irrigation as compared to 44% and 4% respectively twenty years before (Table 5).

*Change in the time of fruit trees flowering*

Climate change research reveals that increasing temperature and changing pattern of precipitation are having noticeable effects on species and ecosystem (Parmesan and Yohe, 2003; Root et al., 2003; Parmesan, 2007). For instance, the geographical distribution of many plants and animal species are shifting toward higher altitudes (Grabherr et al., 1994). Climate change is affecting the timing of plant flowering (Sparks and Carey, 1995; Defila and Clot, 2001; Fitter and Fitter, 2002; Miller and Primack, 2008; Primack et al., 2009).

**Table 5:** Change in water availability for agriculture (1992 to 2012).

Year	Use of Canal water for irrigation		Use of Persian wheel for irrigation		Use of Tube well for irrigation		Use of rain water for irrigation	
	Number	%age	Number	%age	Number	%age	Number	%age
20 year ago (1992)	32	43	6	08	5	07	32	42
At present (2012)	45	60	2	03	18	24	10	13

Source: Field Survey.

**Table 6:** Average change in the time of fruit trees flowering (1992 to 2012).

Name of fruit trees	20 years ago (1992)	Present (2012)	Average change number of days	Standard Deviation
Apricot	12-March	5- March	-6	0.59
Almond	26-February	19-February	-7	0.92
loquat	17-March	12- March	-5	0.73
Orange	19-March	24-March	+5	0.65
plums	04-March	01-March	-3	0.45

Source: Field Survey.

In response to the change in timing of the flowering of fruit trees the respondents unanimously agreed that change has occurred in the time of fruit tree blossoming. They believe that this is because of onsets of early summers and shortening of winter season. However different fruit trees respond differently to the changing climate i.e. some fruit trees like loquat and oranges blossom very early but very little change took place in plums blossoming. Survey results are shown in Table 6.

**Livestock**

Heat stress caused by global warming can affect animal production by decreasing feed consumption, milk production and reproduction (West, 2003). Though most of the respondents reported no significant change in livestock health, an overwhelming majority of respondents (93%) believe that the number of livestock's/household has reduced significantly. Similarly respondent pointed out a change in the source of feed for livestock. Majority of the farmers now relay on market for fodder, since natural fodders and grasses on pastures has been reduced as a results of increasing temperature and decreasing /changing rainfall pattern.

**Natural hazards**

The apparent increase in weather related disasters such as flash flood, river flood and drought etc. are often attributed to global warming and climate change. The respondents were asked about their perception regarding the occurrence of natural hazards. Majority

of the respondent agreed that the frequency of flash floods has decreased; they attributed this to the decrease in the amount of rainfall in last 20 years. Besides the respondents also believe that there is not only decrease in the amount of rainfall but the timing of rainfall is also changed. The analysis of climate data obtained from regional meteorological office Peshawar for a period of 21 years (1990-2009) reveals that the average monsoon rain (July-Sep) during 1990 to 1999 was 369.87mm which decrease to 280.26 during 2000-2009. According to IUCN (2008) in Shigar and Bagrote valleys of Gilgit Batistan the amount of precipitation has reduced drastically in last 10 years. In Shigar and Bagrote valleys the incidents of flash flood increase though because of rapid melting of snow and glaciers.

According to Ahmad et al. (2003) there is generally a decrease or no change in temperature is observed in monsoon region of Pakistan. However there is an increase in extreme temperature in arid region comprising of plain areas, dry mountains and coastal areas. Increase in extreme annual rainfall is observed in the humid, sub humid and semi-arid regions, whereas a decline trend is noticed in cool humid/sub humid, dry mountains and coastal areas of Pakistan. When the question was asked about the trend of flash floods, respondents unanimously agreed that the number of flash floods decreased from last 20 years. The study area Balambat Tehsil is part of dry mountainous region of Pakistan where no big glaciers exist therefore it is understandable that the incidents of flash floods

might be decreased. However when the question was asked about the occurrence of river flood, majority of the respondents believe that the incidents of riverine flood has increased. Most of the sampled villages are located on bank of Punjkora river which take its origin from upper Dir, during its journey a number of streams join it. The melting of snow combined with summer rainfall often cause flood in the river. **Table 7** summarize the survey results.

**Table 7:** Change in the Frequency of the Flash flood and River flood Disasters (1992 to 2012).

Disasters	Sample size	Decrease	% age of Respondents	Increase	% age of Respondents
Flash Flood	75	57	76	18	24
River Flood	75	14	19	61	81

Source: Field Survey.

### Winter getting warmer

Another parameter used in the present research was to determine the respondent perception about the winter season that whether the winters are getting colder or warmer. Though majority of the respondent (84%) unanimously agreed that winters are getting warmer, the snow fall in February 2009 took place after 50 years.

### Conclusions

In Pakistan the climate change research is primarily focused to understand the physical indicators i.e. climatic parameters, water resources, glacial lakes outburst flood (GLOF) and biological indicators like agriculture and natural ecosystem. Very limited work is done to determine farmers/ human perception and adaptation to climate change.

The present research reveals that majority of the farmers/respondents has experienced some changes in relation to different climatic phenomenon over the last two decades. The study demonstrated mixed type of results about the awareness level of the respondents in relation to climate change. Though some respondents were aware of, majority missed the detail information's about climate change. The respondents seem to be more concerned about the weather, rather than the climate. Survey results reveals that respondents had clear perception about the change in heat, cold and rainfall that had occurred in the last 20 years.

Farmers perception of climate change include in-

creased heat, overall warmer winters, reduced and variability of precipitation and severity of riverine floods. As for as adaptation is concerned, most of the respondents have not used any adaptation strategies mainly because of lack of information's. The only adaptation strategy adapted by farmers in the study area is change in crop calendar. Awareness of consequences of climate change was more on reduction in agricultural production as most inhabitants were engaged in farming for sustenance.

### Recommendations

Agriculture is one of the most vulnerable sectors to the impact of climate change and there is an immediate need for proper adaptation strategies. Pakistan in general and the study area in particular has a low financial and technical capability to adapt to climate changes; therefore improving the adaptation capacity of farmers should be considered at highest priority. Unfortunately very little is known about how farmers will adapt to climate change, though they will in some way, because it is in their own interest. However there is dire need to determine to what extent poverty, lack of information about climate change and socio economic factors may constrain that adaptation. There is a need for increase awareness and understanding of climate change effects and impacts for which mass media can be effectively used.

### Author's Contribution

**M. Jamal Nasir:** Analysis of data in GIS and wrote the manuscript.

**Anwar Saeed Khan:** Reviewed the article

**Said Alam:** Prepared questionnaire for survey and collected the data.

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