Research Article

Impact of Climate Change on Agriculture: A Case of Farmers' Perception in Rural Punjab, Pakistan

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Abstract | Climate change is a global issue and becoming severe day by day. Pakistan is developing country, which is also affected by climate change and has no proper resources to hand over these problems creating through change in climate. While Pakistan is country in which agriculture plays as a role of backbone for their economy because a sufficient amount of population connected direct or indirect to this sector. According to Davidson, humans for their improvement in quality life and economical purposes basically cause climate change. We can observe change in climate easily by increasing temperature and irregular pattern of rains. Agriculture and climate have strong relation with each other. So, the agriculture should develop continuously with ever growing population. However, crop productivity of major cereal crops is adversely affected due to weather changing conditions. Farmers have not appropriate resources to recover these gaps produced by climate changes. This study makes an attempt to check farmers' awareness regarding climate. It also inspects the inferences of climate change on major cereal crops like wheat, maize and rice at district level. It is expected that majority of crops under consideration to be harmfully affected by increasing temperature and irregular rainfalls. It is also observed and categorized the sources through information are collected by farmers about changing in climate conditions. In this study, local adaption practices and strategies, private and government institutional support and efforts, national adaption policies and strategies are also surveyed at different scale.

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Introduction

Modernization of agriculture sector is necessitating as coping strategy to tackle climate change and food insecurity especially for developing world (FAO, 2015). However, it is observed that climate change is based on human activities and its stability is thoughtful concern (Davidson *et al.*, 2018). National Oceanic and Atmospheric Administration (NOAA, 2012) confirmed that the year 2002 and 2003 were the warmest of the current century. It is obvious; climate change has direct or indirect

effects on agriculture. Developing countries are more affected by climate change because their economy is based on labor concentrated technologies, however; technology is available in developed countries due to which they can handle climate sensitivities through improved adoption adjustments (Tubiello *et al.*, 2008; Shakoor *et al.*, 2011). Climate change is a global phenomenon but changes in climate conditions are mainly characterized to rise in greenhouse gasses. Rise in temperature, change in rainfall pattern, droughts, floods and negative effect on land resources caused by fluorinated gases, CO_2, nitrous oxide and methane (Ali *et al.*, 2017; Kaur, 2017). Agriculture sector is more vulnerable to climate change causing shortage of water availability, biodiversity loss, land degradation and air pollution etc. Whereas it is also perceived that the increase in temperature between 2-4ºC can make progress in yields of some crops for example an increase in yield of rice crop is projected in Malaysia and Indonesia yet more losses are expected in Philippines (Barik and Da, 2019). Countries facing scarcity of resources are severely affected due to climate change and their yield is also declining. In South Asia and Africa, cereal crops like wheat sorghum and maize are estimated to suffer loss of 8% yield up to 2050. In rural areas, small-scale farmers are mainly vulnerable because their livelihoods are mostly based on agriculture (Parker *et al.*, 2019).

In Asian countries, it is observed that warming is constantly rising across the region. However, heavy rainfall can be expected for producing floods although dry spells are going to be drier. These changes are becoming threats for sustainable agricultural productivity (Salman *et al.*, 2018). These changes are also serious threats for farmers living in marginal region and isolated areas such as mountains, desert areas, and dry lands where natural resources are poor. Arid region of Pakistan, western area of China and arid area of India are more vulnerable to climate change. Majority of rural poor people are living in rain fed areas where due to increase in temperature water stress is rising and production of maize, rice, wheat is decreasing in last few decades. In 2050, it is estimated that this vulnerable condition of climate can reduce 50% of wheat production (Shakoor *et al.*, 2011). Overall, the world climate change is global issue but it's also a big threat for Pakistan, being developing country faces negative consequences on agricultural growth particularly cereal crops. Climate changes are adversely affecting food production, industrial development, job creations and poverty reduction in the country (Ali *et al.*, 2019). According to IPCC (2019) report the glaciers of Pakistan in Himalaya region are melting rapidly as compared to any other part in the world and if condition will be same in future, then they could be disappearing in year 2035 (Shahid and Piracha, 2016).

Research and academia should initiate interventions to make the people aware about environmental and climatic changes and their consequences on crop productivity (Meng and Xiong, 2018) moreover, convincing farmers to enhance the usage of agricultural land and crop rotation to reduce the adverse effects of climate change (Aragón *et al.*, 2018). It is worth mentioning that 70% population of the world is living in rural areas and they directly or indirectly engaged in crop production (Barik and Da, 2019). The agricultural experts and professional can play an important role to enhance awareness among community of all levels to mitigate impact of climate change through education. However, it is more important that training should be recommended for these professionals (Jamshidi *et al.*, 2018).

Extreme climatic conditions in Pakistan are great challenge for production of major cereal crops (wheat, rice and maize etc.) and threat for food security and its economy highly depends on agriculture therefore, adaptation strategies should be on prime aim for farmers to gain maximum production. Overall, climate change has negative impacts on production so government should take strict action on these problems for better crop productivity (Ali *et al.*, 2017; Siddiqui *et al.*, 2012).

Pakistan has wheat, rice and maize etc. as major cereal crops to fulfill needs of staple food and all these crops are directly connected to suitable climatic conditions for progressive growth. In advanced countries modern technologies are used and they can handle properly bad climate conditions as possible to them. They are using resistant and improved verities considering climate, organic fertilizers, pesticides and latest harvesting and irrigation technologies like sprinkler, drip irrigation system etc. but in Pakistan these technologies are still in transition, not fully adopted by the farmers due to diversified issues. Farmers are migrating towards urban areas due to irregular rains, droughts, floods and irrigation issues and to fulfill their economic necessities because they have not sufficient tools and

technology to handle these conditions properly. Too many problems are created by climate variation for the farmers and these multifarious problems can be evaluated by conducting research activities on this emerging issue. Therefore, present study was designed to explore various consequences of climate change on agriculture as perceived by the farmers.

Materials and Methods

Study area, universe and sampling

The current study was conducted in district Narowal of the Punjab province. This district's boundaries are attached to Sialkot district in northwest, State of Jammu on north, Gurdaspur district (India) on east, Amirtsar district (India) and Sheikhupura district on South. District Narowal has three tehsils; Zafarwal, Narowal and Shakargarh. The major cereal crops are wheat, rise, maize, sorgum and millet etc. The soil of this area has fertile, productive, heavy and supreme fit for farming of wheat, rice and maize. In this area tube-well is main source for irrigation because it is totally deprived of canal system. Due to which, cost of irrigation water is expensive as compared to other areas of country. Thus, for current study the district Narowal was considered as universe. Simple random sampling technique was adopted to draw appropriate sample for this study. Six villages were selected from each tehsil randomly (Table 1). Then from each selected village list of farmers was obtained and from each list of villages ten farmers were selected randomly hence, the total sample size was 180 respondents (Figure 1).

An interview schedule was prepared for the collection of data. Which was composed of different segments i.e. demographic characteristics (education, family size, monthly income, source of income, farming experience, size of land holding, cereal crops grown and land holding), farmers' awareness (included on fourteen questions like fluctuating temperature, deforestation and change in rain fall pattern etc.), source of information for farmers' regarding climate change (print media, cell phone and TV etc.), farmer perception on climate change (crop ripening, yield of crops and seed germination etc.), Management strategies (use of compost/organic fertilizers, use of certified seed and crop rotation etc.) institutional (public/private) management strategies (awareness policies and implementations, awareness trainings/ workshops and climate change monitoring cells etc.), extension organizations (develop linkage, conduct farmer gathering and provide inputs timely etc.), barriers (high price of inputs, soil erosion prevention measures and lack of awareness among farmers about climate change etc.).

Pre-testing and data analysis

Interview schedule was pre-tested to check its strength and validity. However, it was pretested by using 15 farmers in a village of sample area. The main purpose of pre-testing was to correct errors and omissions if any. Pre-tested farmers were not included in the final list of respondents. After pre-testing interview schedule was improved for collection of data. Interview schedule was prepared in English language but during the interview all questions were asked in local language (Urdu or Punjabi) for the convenience of the farmers. The collected data were coded in Microsoft Excel and analyzed using SPSS (version-22). Descriptive statistics like mean, frequency and standard deviations were applied with the help of SPSS. Analyzed data were interpreted and tabulated for final draft.

Results and Discussion

Socio economic attributes

Socio economic characteristics have significant impact on the development of any society whether it is rural or urban. Level of development in an area can be checked by the socio-economic characteristics of the people living in that area. In developing countries unemployment is high, young human capital is less, education level of the people is not encouraging and people are poor. The data concerned to socio-economic attributes including; age, education, family size, monthly income, major source of income, farming experience, land holding and cereal crop grown. The data is also presented in Figure 2.

Age distribution of the respondents as presented in figure, shows that majority of the respondents (62.80%) were between the age category of 41-60 years. There were only few (3.30%) respondents with age in the category of up to 25 years whereas 21.10% of the respondents were between the age group of 26-40 years. It can be seen that 12.8 % of the respondents were in the age category of more than 60 years. With regard to education, the results showed that 12.80 per cent of the farmers were illiterate, while 34.40 per cent and 7.20 per cent farmers studied up to primary school and middle school, respectively. Similarly, about

22.20 percent and 23.30 percent farmers studied up to matric and intermediate and above levels of study respectively. The results indicates that 25 percent of the respondents possess 1-5 family members, whereas 70.50 percent and 4.50 percent possess 6-10 and above 10 family members, respectively.

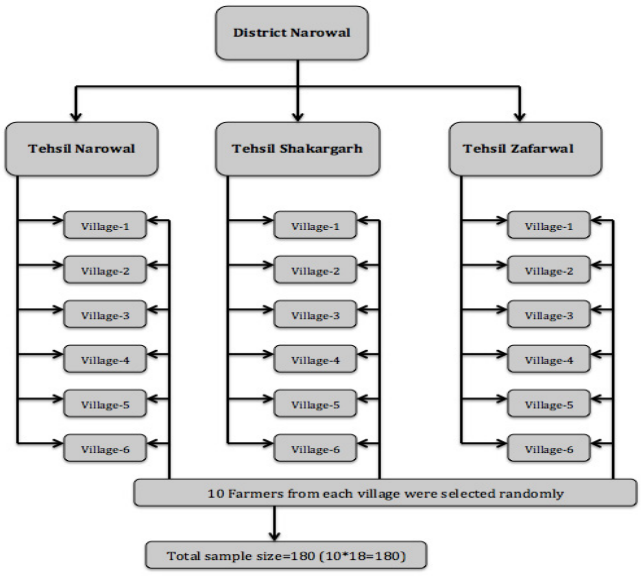

Figure 1: *Sampling for data collection.*

The monthly income of the respondents shows that most of the farmers' earning range was 31-50 thousand rupees (Pak.) per month, 28.90 percent and 27.20 percent of farmers have monthly income range of 51-100 thousand rupees (Pak.) and up to 30 thousand rupees (Pak.) per month respectively. While 2.80 percent of farmer's earning range was above 100 thousand rupees (Pak.) per month. People may have single or multiple sources of income. Some people may have Govt./private job along with agricultural income. The total annual income of respondents reflects their economic position, which may affect their adoption of agricultural innovations. It was therefore, planned to acquire information regarding source/s of income of the respondents. The data regarding this aspect is also highlighted in given in Figure 2. According to this data 55 percent of respondents possess only agriculture as major source of income. While, 22.8%, 11.1%, 6.7% and 4.5% of respondents possess government job, business, private job, and labor as major source of income, respectively.

Experience in agricultural fields provides competencies regarding production technology of different crops, management practices and all the other field activities. The field experience of the farmers is presented in Figure 2 which indicates that majority (36.1%) of the farmers possess 1-10 years' experience, while 26.1% of the respondents possess 21 to 30 years of experience. The respondents who had 11-20 years field experience were 22.8% and there were 12.2% respondents who had experience from 31-40 years. Only 2.8 percent respondents possess above 40 years of farming experience. To check the total land holding status of the respondents tells us the economic position of the respondent, which may affect his/her social dealings. It was therefore, planned to acquire information regarding land holding of the respondents. The data regarding this aspect is also presented in Figure 2. It reflects that majority (57.2%) of the farmers belonged to small farmers category having 1-12 acres of land, and 27.8 percent of the farmers have land size of 13-25 acres. However, 11.7 percent and 3.4 percent of the farmers possess 26-50 acres and above 50 acres, respectively. The study area was selected for this research has grown two major crops wheat and rice. Data related to crops grown by the respondents in research area presented in Figure 2 illustrates that majority (77.2%) of the farmers are growing wheat as major crop, while 15.5% and 7.3% of farmers are growing rice and maize as major crop in the research area.

Table 1: *Selection of villages from different tehsils of district Narowal.*

Village No.	Tehsil Narowal	Tehsil Shakargarh	Tehsil Zafrwal
Village-1	Badomali	Maingre	Bara pind
Village-2	kila Ahmad Abad	Kasraj	Garpal
Village-3	Kamalpor Chishtiyan	Majra	Lohara
Village-4	Bobak Marali	Fatah Por	Uncha Klan
Village-5	Alya Abad	Kot Nianan	Darma
Village-6	Thamthal	Akhlas Por	Laser

Awareness among the farmers regarding climate change

The level of awareness was operationalized as the degree to which the farmers had information related to climate change and potential consequences. The adaptation level of people to the adverse impact of climate change depends upon their awareness level.

The Table 2 reveals the data regarding awareness about climate change of farmers. In which, awareness of farmers about fluctuating temperature was ranked at first with mean value of 4.21 while changing in rainfall pattern was ranked at 2nd with mean value of 4.01. Increase in pest and disease was ranked at

3rd with mean value of 3.97, whereas increase in environmental pollution was ranked at 4th with mean value of 3.95. The mean value for variation in clouds and thunders was 3.89 and it was ranked at 5th whilst the mean value of changing in planting and harvesting time was 3.87 and it was ranked at 6th. However, in case of changing pattern of air and windstorms mean value was 3.83 due to which it was ranked at 7th stage while at the same time increase in production cost was ranked at 8th stage with mean value of 3.74. Although, deforestation was ranked at 9th position with mean value of 3.7 while increase in floods was ranked at 10th place with mean value of 3.62 but both variables like decrease in biodiversity and conducive environment for livestock production and management at 11th stage due to their same mean values 3.55. Even as soil degradation due to erosion was ranked at 12th place with mean value of 3.50.

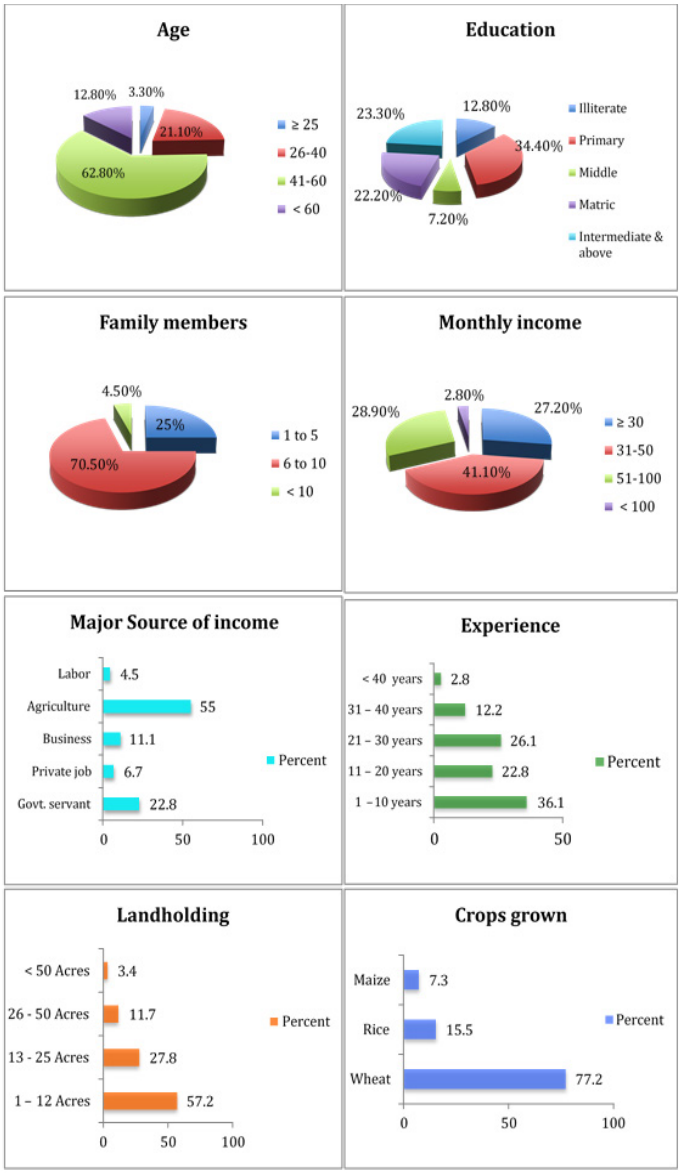

Figure 2: *Socio-economic attributes of the respondents.*

Table 2: *Farmer's awareness about impact of climate change (n=180).*

Variable	Mean	SD
Fluctuating temperature	4.21	0.85
Change in rainfall pattern	4.02	1.02
Increase in pest and diseases	3.97	1.11
Increasing environmental pollution	3.95	1.16
Variation in clouds or thunders	3.89	0.99
Change in planting/ harvesting time	3.87	1.03
Changing pattern of air or wind storms	3.83	0.98
Increase in production cost	3.74	0.99
Deforestation	3.70	1.20
Increase of floods	3.62	1.16
Decrease in biodiversity	3.55	1.05
Conducive environment for livestock production and management	3.55	0.99
Soil degradation due to erosion	3.51	1.12
Change in drought or dry spells	3.48	1.13

Scale: 1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree, 5= Strongly Agree.

Table 3: *Effectiveness of the information received related to climate change (n=180).*

Variable	Source of information		Effectiveness	
	Mean	SD	Mean	SD
Cellphone	3.72	1.26	3.16	0.93
TV/Radio	3.35	1.39	3.00	1.04
Internet	3.17	1.52	3.04	1.02
Agents of public sector	3.14	1.23	2.79	1.04
Agents of private companies	3.07	1.33	2.74	1.16
Farming group	3.04	1.24	2.96	3.10
Agriculture magazines	2.81	1.30	2.72	1.00
Print media	2.80	1.19	2.60	0.98
Community organization	2.73	1.29	2.43	1.07
NGOs	2.59	1.38	2.52	1.11

Scale for source of information (1=Never use, 2= Rarely use, 3= Sometimes use, 4= Often use, 5= Always use) Scale for effectiveness (1=No affect, 2=Minor affect, 3=Moderate affect, 4=Major affect).

Table 3 determines the effectiveness of the sources of the information through which formers get facts and figures about climate change. Most of the respondents used their cell phone for getting information due to which its effectiveness is more than any other source and it was ranked at 1st stage with mean of 3.15 after that internet was ranked at 2nd with mean value of 3.03. Although, TV/Radio and farming groups were at 3rd and 4th stages, respectively with mean value of 3.00 and 2.96. However, agents of public sector were ranked at 5th place with mean value of 2.79. While,

with slightly difference in between agents of private companies and agricultural magazines both were placed gradually at 6th and 7th with mean value of 2.73 and 2.72. As same as, print media and NGOs was also participating with mean value of 2.60 and 2.52 and ranked at 8th and 9th stages gradually. Whereas, community organizations and other resources was ranked 10th and 11th stage within mean value of 2.42 and 2.00, respectively.

Table 4: *Climate change impacts on cereal crops as perceived by the respondents (n=180).*

Variable	Mean	SD
Seed germination	3.26	1.67
Harvesting period	3.21	0.81
Crop ripening	3.19	0.87
Effect on growth	3.18	0.85
Yield of cereal crops	3.16	0.87
Quality of cereal crops grain	3.09	0.87
Cultivation period	3.08	0.87
Use of fertilizers and pesticides	3.05	0.85
Marketing of produce	3.02	0.97
Soil moisture	2.86	0.91

Scale: 1=No affect, 2=Minor affect, 3=Moderate affect, 4=Major affect.

Table 4 reveals the farmer perception regarding effects on cereal crops through climate change. In which seed germination was ranked at 1st stage with mean value of 3.26 after that harvesting period was ranked at 2nd with mean value of 3.20. However, in yields of crops and effect on growth there was very close difference of 0.1 like as each mean value was 3.19 and 3.18 and ranked at 3rd and 4th numbers respectively. Although, yields of cereal crops and quality of cereal crops grain were at 5th and 6th stages respectively with mean value of 3.15 and 3.09. While, with slightly difference in between agents of cultivation period and use of fertilizer and pesticides both were placed gradually at 7th and 8th with mean value of 3.07 and 3.05. As same as, marketing of produce and soil moisture was also participating with mean value of 3.01 and 2.86 and ranked at 9th and 10th stages gradually.

Table 5 shows the strategies used by the farmers through which effects of climate change can be reduced. Judicious use of chemical fertilizer or pesticides was ranked at 1st stage with mean value of 2.41 after that use of composite or organic fertilizer was ranked at 2nd with mean value of 2.39. Although, use of certified seed and crop rotation were at 3rd and 4th stages, respectively with mean value of 2.36 and 2.30. While, with faintly difference in between adopt water saving technologies and utilize soil conservation techniques both were placed gradually at 5th and 6th with mean value of 3.07 and 3.05. As same as, diversification of crops was ranked at last stage 7th position with mean value of 2.03.

Table 5: *Farmer level management strategies to climate change adaptation (n=180).*

Variable	Mean	SD
Judicious use of chemical fertilizer or pesticide	2.42	0.66
Use of compost or organic fertilizer	2.39	0.69
Use of certified seed	2.37	0.68
Crop rotation	2.31	0.76
Adopt water saving technologies	2.24	0.74
Utilize soil conservation techniques	2.08	0.77
Diversification of crops	2.03	0.72

Scale: 1=Never, 2=Sometimes, 3=Always

Table 6: *Public and private sector institutional management strategies to climate change adaptation (n=180).*

Variable	Public sector institution		Private sector institution	
	Mean	SD	Mean	SD
Campaigns through electronic media	3.52	1.18	3.78	1.07
Massive tree plantation campaigns	3.46	1.16	3.41	1.25
Research on soil and water conservation technologies	3.26	1.22	3.51	1.17
Facilitating farmers to adopt conservation technology	3.26	1.18	3.55	1.15
Capacity building of extension staff	3.25	1.26	3.53	1.18
Awareness training or workshops	3.18	1.20	3.73	1.14
Climate change monitoring cells	3.16	1.30	3.42	1.29
Implementing pollution reduction strategies	3.14	1.28	3.42	1.10
Waste management services	3.13	1.21	3.40	1.19
Awareness policies and implementations	2.85	1.27	3.54	1.14

Scale: 1=Strongly disagree, 2=Disagree, 3=Un-decided, 4=Agree, 5=Strongly Agree.

Table 6 demonstrates the public institutional management strategies to minimize climate change impacts on the cereal crops. Most of the respondents choose campaign through the electronic media for getting information to minimize climate change impacts due to which it was ranked first with mean value of 3.52 while massive tree plantation was ranked at 2nd with mean value of 3.46. Although, facilitating farmers to adopt conservation technologies and research on soil or water conservation technologies were at 3rd and 4th stages, respectively with mean value of 3.26 and 3.256. While, Capacity building of extension staff and awareness training or workshops both were placed gradually at 5th and 6th with mean value of 3.250 and 3.18. However, in case of climate change monitoring cells and implementing of pollution reduction strategies as both mean values were 3.15 and 3.14, there was slightly difference between them of .01 and ranked at 7th and 8th numbers respectively. As same as, waste management services and awareness of policies and implementations with mean value of 3.12 and 2.585 and ranked at 9th and 10th stages gradually.

Table 6 also shows the private institutional management strategies to minimize climate change impacts on the cereal crops. Most of the respondents choose campaign through the electronic media for getting information to minimize climate change impacts due to which it was ranked first with mean value of 3.78 while awareness training and workshops was ranked at 2nd with mean value of 3.73. While, with slightly difference in between facilitating farmers to adopt conservation technologies and awareness policies and implementations both were placed gradually at 3th and 4th with mean value of 3.55 and 3.54. However, in case of capacity building of extension staff and research on soil and water conservation technologies story is same with very close difference of 0.1 like as each mean value was 3.52 and 3.51 and ranked at 5th and 6th numbers respectively. However, in case of climate change monitoring cells and implementing of pollution reduction strategies as both mean values were 3.42 and 3.42, both variables had same mean value due to which they were ranked at same place at same place 7th position. As same as, massive tree plantation campaigns and waste management services with mean value of 3.42 and 3.40 and ranked at 8th and 9th stages gradually.

Table 7 explains the public sector extension organizations creating awareness about climate change. Provide agriculture loans was ranked at 1st stage with mean value of 2.30 after that conduction of workshops and seminars was ranked at 2nd with mean value of 2.19. Although, conducting of farmer gathering and develop linkage were at 3rd and 4th stages respectively with mean value of 2.17 and 2.03. While, with faintly difference in between launch of training programs and provide inputs timely both were placed gradually at 5th and 6th with mean value of 1.97 and 1.94. As same as, advisory services at doorsteps were ranked at last stage 7th position with mean value of 1.84.

Table 7: *Public/private sector extension services for climate change awareness (n=180).*

Variable	Public sector		Private sector	
	Mean	SD	Mean	SD
Provide agricultural loans	2.31	0.81	2.26	0.78
Conduction of workshops and seminars	2.19	0.74	2.50	2.24
Conduct farmer gathering	2.18	0.75	2.38	0.71
Develop linkage	2.03	0.80	2.21	0.75
Launch of training programs	1.98	0.75	2.36	0.72
Provide inputs timely	1.94	0.75	2.28	0.75
Advisory services at doorstep	1.84	0.77	2.24	0.75

Scale: 1=Never, 2= Sometimes, 3= Always

Table 7 also describes the private sector extension organizations creating awareness about climate change. Conduction of workshops and seminars was ranked at 1st stage with mean value of 2.50 after that conduction of farmer gathering was ranked at 2nd with mean value of 2.38. Although, launching of training program and provide inputs timely were at 3rd and 4th stages respectively with mean value of 2.36 and 2.27. While, with slightly difference in between provide agriculture loans and advisory services at doorstep both were placed gradually at 5th and 6th with mean value of 2.25 and 2.24. However, develop linkage was ranked at last stage 7th position with mean value of 2.21.

Table 8 explains the barriers with regard to climate change adaption in agriculture. Most of the respondents thought that lack of awareness among farmer is major barrier for adaptation in agriculture with mean value of 4.25 and ranked first although high prices of inputs was ranked at 2nd with mean value of 4.12. After that, excessive use of fertilizers and also pesticides and less adaption of modern agriculture

technology were at 3rd and 4th stages respectively with mean value of 3.97 and 3.92. While, with slightly difference in between inadequate integrated pest management and lack of social equality and governance both were placed gradually at 5th and 6th with mean value of 3.90 and 3.88. However, in case of lack of access to government department or institutions and insufficient infrastructure and collaborative networks story is typical with same mean value 2.86 ranked at 7th stage. As same as, Lack of appropriate varieties for cultivation and lack of information skills and management ware also participating with mean value of 3.84 and 3.78 and ranked at 8th and 9th stages gradually. As same as, lack of multiple economic resources and soil erosion prevention measure were ranked at 10th and 11th position with mean value of 3.73 and 3.70. Whereas, at last number ranked 12th place was shrinking of livelihood due to climate change with mean value of 3.40.

Table 8: *Barriers to climate change adaptions as perceived by the respondents (n=180).*

Variable	Mean	SD
Lack of awareness among farmers about climate change	4.26	0.95
High prices of inputs	4.13	1.04
Excessive use of pesticide and fertilizer	3.97	1.14
Less adoption of modern agricultural technology	3.92	1.02
Inadequate integrated pest management	3.90	1.03
Lack of social equality and governance	3.89	1.03
Insufficient infrastructure and collaborative networks	3.86	1.07
Lack of access to govt. departments or institutions	3.86	1.11
Lack of appropriate varieties for cultivation	3.84	1.21
Lack of information skills and management	3.78	1.05
Lack of multiple economic resources	3.73	1.11
Soil erosion prevention measure	3.70	1.13
Shrinking of livelihood due to climate change	3.40	1.05

Scale: 1=Strongly disagree, 2=Disagree, 3=Un-decided, 4=Agree, 5=Strongly Agree.

Conclusions and Recommendations

The majority of the farmers in the research area are 41-60 years old possessing primary-level education, similarly, the majority of the farmers have 6-10 family members, 31-50 thousand PKR monthly income, and agriculture as a source of income. The majority of the farmers possess 10 years of farming experience having 1-12 acres of land, and growing wheat as a major cereal crop. The overwhelming majority of the farmers do believe "fluctuating temperature" is a prominent impact of climate change. Farmers considered cell phones as the best source of information related to climate change and also considered it the most effective tool to get awareness about the climate change impacts on agriculture. Farmers also perceived that climate change has a moderate level impact on seed germination as well as on the harvesting of cereal crops in the research area. Farmers considered the "judicious use of chemical fertilizer or pesticide" as a management strategy by the farmers to be used sometimes in the research area. Farmers in the research area agreed to "campaigns through electronic media" as a management strategy to be used by the public sector as well as by the private sector institutions. Farmers considered "lack of awareness among farmers about climate change" as the most intervening barrier to climate change adaptation at the farm level.

Based on the conclusion given below are some recommendations for the public and private sector institutions to initiate policies regarding climate change and adaptation strategies in the agriculture sector of Pakistan:

- Public and private sectors should launch massive awareness campaigns regarding climate change impact on agriculture.
- Messages related to climate change adaptation should be developed by extension service providers and delivered to the farming community to raise awareness regarding climate change impacts on agriculture.
- Judicious use of inputs (especially fertilizer and pesticide) should be encouraged at the farmer level by extension field staff.

Conflict of interest

The authors have declared no conflict of interest.

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