



EVALUATING DETERMINANTS OF CLIMATE CHANGE PERCEPTION AMONG FARMING COMMUNITIES IN DISTRICT MARDAN, KHYBER PAKHTUNKHWA-PAKISTAN

Muhammad Afnan Raza ¹ and Sana Ullah * ²

ABSTRACT

This research endeavor, conducted in year 2019-20, explores farmers' perception regarding climate change and the impacts of socioeconomic indicators affecting these perceptions in district Mardan, KP-Pakistan. For this purpose, total of 140 sampled respondents, seventy from each village were selected for primary data collection. Ordered probit model was used to quantify the determinants of climate change perception. Demographic characteristics revealed that average age of the respondents was 44.42 years, with average schooling, household size, farming experience and farm size of 7.73 years, about 9.96 members, 27.90 years and 3.1 acres, respectively. The study findings indicated that age, education, household size, farming experience, total income and nature of land significantly ($p < 0.05$) affect farmers' perception of climate change specifying that younger farmers perceive climate change impacts more as compared to older farmers, while experienced were more likely to perceive than inexperienced. Educated farmers perceived changes in climate more than less educated or uneducated. Small holders perceived more than big landlords, rain-fed farm holders perceived more than irrigated farm holders, high income farmers perceived more than low income farmers, owners perceived more than owner-cum tenants and tenants and small families perceived more than big families. The study recommended climate change awareness programs through government and non-government organizations, i.e. education programs, farmer field schools (FFS), agricultural extension agencies to bridge the farmer- research gap, government role in realistic land reforms, establishment of farm services centers (FSCs), climate information centers and diversify farm income opportunities.

¹ MS Student, Department of Agricultural & Applied Economics, The University of Agriculture, Peshawar,

² Ph.D. Scholar, Department of Agricultural Leadership, Education & Communication, College of Agricultural & Environmental Sciences, The University of Georgia, USA

*Corresponding author's email: sana.ullah@uga.edu

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INTRODUCTION

Climate change is one of the greatest global challenges of the modern age. Climate change is an externality and its process is multidimensional in nature (Stern, 2007). The agricultural sector of Pakistan faces some serious threats arising from global warming, environmental degradation and climate change. These threats/challenges may lead to sizeable productivity losses in this sector (Lu *et al.*, 2011). As farming communities are dependent on this sector as a source of livelihood so these losses affect overall rural welfare. Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (UNEP, 2009). Climate change has been defined by the Intergovernmental Panel on Climate Change (IPCC) as statistically significant variations that persist for an extended period, typically

decades or longer (IPCC, 2014).

Climate change is the change in average weather/climatic parameters characterized by the slow and continuous rise in the global mean surface temperature and a shift in the frequency, magnitude and intensity of the spasmodic weather events (Farauta *et al.*, 2011). It includes change in the pattern, intensity and amount of rainfall, change in the sea level, melting of glaciers, long dry seasons associated with shorter winters and longer summers, soil erosion, occurrence of extreme events- flash floods, drought and water stress, dry spell, cyclones and so on (Raza and Ahmad, 2015; Uddin *et al.*, 2017; IFDA, 2010)

Agriculture is not only the mainstay of rural food and economy but also serves as a major portion of the national economy that accounts for about 18.5 percent of the GDP, livelihood source for 38.5 percent of rural

population and engages around 67 percent of the total rural population directly or indirectly (Sanaullah *et al.*, 2020). Agriculture comprises four sub divisions, including crops, livestock and poultry, fishery and forestry. Major crops, minor crops, livestock and poultry contributes 21.5%, 11.2%, 60.5, 6.8% to value addition in agriculture respectively, while contributes 4.06%, 2.08%, 11.2% and 1.16% to GDP respectively. Fishery plays an important role in Pakistan's economy and is considered to be a source of livelihood for the coastal inhabitants (GoP, 2019).

Agriculture sector of Pakistan not only supply foods and fibers but also has a vital role in rural economy, economic development, rural poverty reduction and food security (Sanaullah and Pervaiz, 2019). Agriculture sector is not only a reservoir of surplus labor but also provides raw materials to industrial sector. Agricultural produce and products are the main source of foreign exchange earnings (Raza *et al.*, 2012). Economic performance in terms of agricultural productivity, agricultural prices, economic growth and food security is influenced by the relationship between agriculture and climatic parameters- temperature and precipitation (IUCN, 2008).

It is an evident that climate change has significant negative impacts on agriculture and poses a critical challenge to sustainable growth in terms of environmental and ecosystem services, agricultural productivity and livelihood and social welfare (Seo, 2008; Lippert, *et al.*, 2009; Thapa and Joshi, 2010; Kim *et al.*, 2011). Climate change and variability leads to losses in agriculture sector accompanied with economy wide consequences like loss in GDP, agricultural productivity, livelihood, fall in the income and consumption (Diao, 2010), affecting health, biodiversity, natural resources and environmental degradation and adversely affects poverty reduction programs, economic growth and social-economic welfare (Parry *et al.*, 2007a, Parry *et al.*, 2007b; Pouliotte *et al.*, 2009). This creates obstacles in the way of innovative technology development, environmental conservation and adoption of such modern technologies to enhance rural livelihood (Sekar and Ramasamy, 2001; Koundouri *et al.*, 2006; Tambo and Abdoulaye, 2013).

Climate change impacts are multidimensional that is its impacts are observed in almost every sectors such as social, economic and political (Karimifard *et al.*, 2016). Some of these impacts are so severe that it considerably affects human welfare in terms of food energy and health security (IPCC, 2014). Climate change and variability has substantively negative impacts on food and food production, food security and natural resources globally constraining

sustainable economic development, poverty reduction efforts, worsen the existing persistent challenges and difficulties especially in developing countries whose economies are deeply rooted in climate sensitive sector of agriculture (Diao, 2010; Kemausuor *et al.*, 2011). Climate change has changed the timing, quantity and pattern of precipitation, drought cycles, increased incidence of pests and diseases and occurrence of severe weather events (Hewitson, 2010; Yanda, 2010). More prominently, decline in farm productivity is the outcome of climate change (Makungwa, 2010).

Climate change is a global phenomenon but its effect is firstly felt on the local level (Abas *et al.*, 2017) and its impacts are more revealing in developing countries (Adger *et al.*, 2003; IFAD, 2010). Climate change and agriculture has cross-effect on each other (Tambo and Abdoulaye, 2013). Emissions from various farming practices affect climate change which in turn affects farm productivity (Makungwa, 2010), food security and farm income due to erratic rainfall and high temperature (Apata, 2011; Deressa *et al.*, 2011). Pakistan being an agrarian economy is climate sensitive; any change in climatic parameters directly and indirectly affects agro-based economies. Based on per capita GHGs emission, the rank of Pakistan is 135th (GoP, 2018) but based on Climate Vulnerability Index, it ranks 5th most vulnerable country to climate change impacts (Kreft *et al.*, 2016; Eckstein *et al.*, 2019). These changes lead to increase in the susceptibility of agriculture, forest and water resources upon which large proportion of population depends for their livelihood (Nizami and Robled, 2010).

The impacts of changing climate caused by increased temperature, fluctuations in precipitation and extreme weather events are extremely evident in the agriculture sector of Pakistan (World Bank Report, 2013). For agriculture sector, these changes have posed various challenges in the form of sustained droughts, water stress, glaciers melting, erratic and unpredictable rainfall patterns, water logging, soil erosion and incidence of extreme climatic events like floods, cyclones that leads to damages to agricultural production (Rasul and Ahmad, 2012; Fisher *et al.*, 2015; Wossen *et al.*, 2017). Climate change and its associated adverse impacts are seemingly apparent in Pakistan. In south Asian countries, Pakistan is seriously affected from climate change impacts (Ahmad and Zulfiqar, 2019). It is projected that in the arid regions these changes will have severe impacts and may affect physical, biological and socioeconomic environment of the inhabitants and it may shift the arid regions' boundaries and crop growing season toward the north (Khan *et al.*, 2012).

The process of adaptation to changing climate has two phases; the first phase is concerned with farmers to perceive and recognize change in climate, while the second phase is related to adaptation and mitigation of the changes in climate (Elum *et al.*, 2017). Adaptation of farmers to changes in ecosystem and new technology adoption and successful implementation is influenced by their propensity to perceive and respond favorably to changes in climate and environmental ecosystem (Roco *et al.*, 2015). Farmers' knowledge on climate and climate issues is sometime imperfect and limited. For effective adaptation to climate change and capacity building, rural communities' perceptions on climate change and variability is important to create effective participatory methodology. Understanding rural farmers' perception of climate change is critically essential as without perceiving it first, it is impossible to construct an appropriate approach for the preparedness of farmers to adapt and change the practices (Speranza, 2010; Khan *et al.*, 2019).

For effective designing of policy to tackle the challenges posed to rural communities by climate change, it is necessary to have insight of climate change perception of farmers, their choice and methods of adaptation and obstacles involving adaptation to climate change (Acquah, 2011). A sound recognition regarding climate change perception, adaptation and factors affecting adaptation practices by farmers is necessary to shape policies and programs meant for successful adaptation in agriculture sector (Bryan *et al.*, 2009). For effective adaptation to climate change, farmers need to have correct perceptions about the prevailing scenario of climate and possible future trends (Kahan, 2008).

The fact that climate not only changed in past but will change in the future, emphasizes the necessity to understand farmers' perceptions and adaptation to changing climate. Farmers perceive climate change and to reduce the negative impacts they also adapt necessarily (Ishaya and Abaje 2008; Mertz *et al.*, 2009). Climate change perceptions play a crucial part in influencing decision making of farmers regarding proactive measures regarding adaptation against climate extremes. Therefore, rural communities' perception on climate change is one of the central features that is necessary to be considered in studies related to changing climate (Deressa *et al.*, 2011). Keeping in view the prominence of farmers' perception about climate change adaptation, the present study were intended to examine farmers' perceptions of the climate change particularly changes in rainfall and temperature in district Mardan, Khyber Pakhtunkhwa Province of Pakistan. Furthermore, the study was designed to figure out the impact of socio-economic attributes of

the respondents on the perception of climate change and to investigate their farm productivity under changing climate.

MATERIALS AND METHODS

Study area and sampling

Current study was conducted in October 2019 to April 2020 in two villages of the study area of Mardan district, Pakistan. In this regard, total of 140 sampled respondents, seventy (70) from each village, were selected through random sampling as well as purposively sampling method because charchor was rianfed area, while chaparabad was irrigated area to study the climate change perception based on nature of land. Graphical representation of study and study are given in Fig. 1 and 2.

Data collection

Primary cross sectional data were recorded using a pre-structured interview schedule which was pre-tested in the study area so as to develop and modify it further by considering all appropriate and necessary questions. Each respondent was interviewed individually through face to face meetings.

Analytical model: Ordered probit model

In statistics, ordered probit was a generalization of the popular probit analysis to the case of more than two outcomes of an ordinal dependent variable. For the present study, the dependent variable (climate change perception) was measured on likert scale from 1 (low) to 3 (high). For instance a farmer was asked to rank his perception of change in rainfall, change in temperature and incidence of pest and diseases due to climate change. The use of ordered probit model seems appropriate in this case to model the effect of socio-economic characteristics on farmers' climate change perception. A general form of the ordered probit model given as;

Such as

$$Y_i = x_i\beta + u_i$$

$$Y_i = j \text{ if } \alpha_{j-1} < Y_i \leq \alpha_j$$

$$Y = 0 \text{ if } Y^* < \alpha_1$$

$$Y = 1 \text{ if } \alpha_1 < Y^* \leq \alpha_2$$

$$Y = 2 \text{ if } Y^* > \alpha_2$$

Thus

$$\Pr [Y = 0] = \Pr [Y^* < \alpha_1]$$

$$\Pr [Y = 1] = \Pr [\alpha_1 < Y^* \leq \alpha_2]$$

$$\Pr [Y = 2] = \Pr [Y^* > \alpha_2]$$

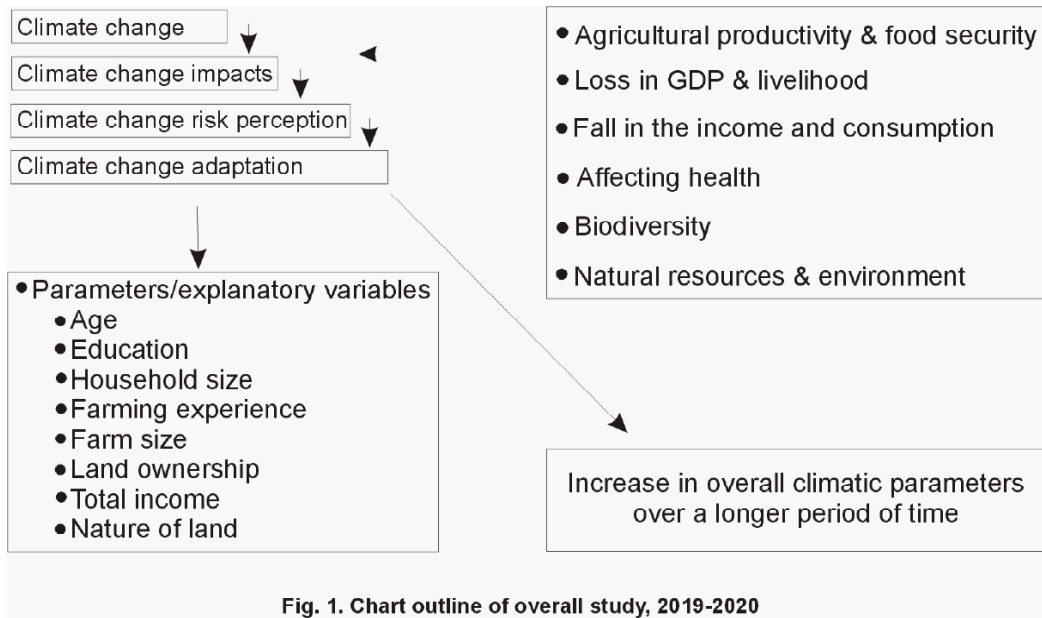


Fig. 1. Chart outline of overall study, 2019-2020

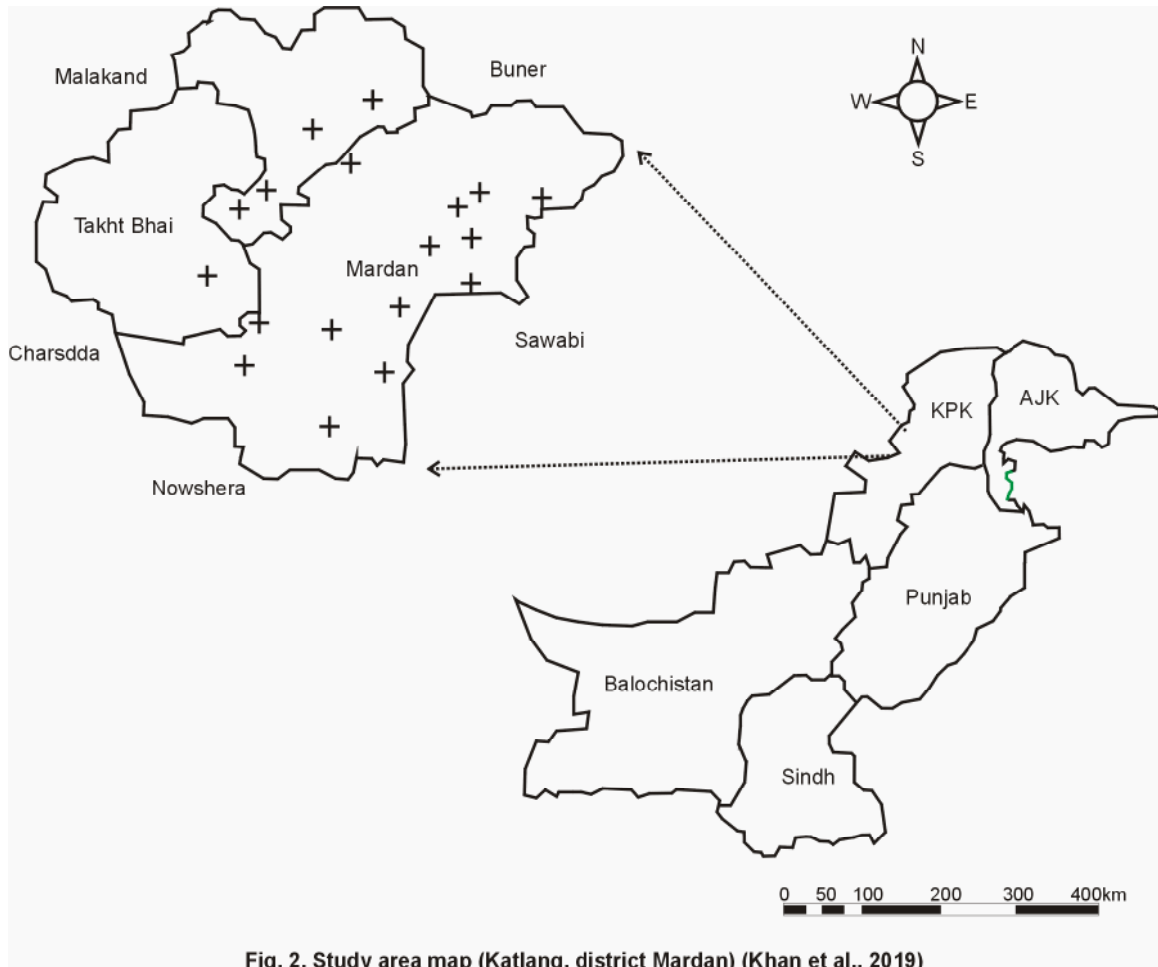


Fig. 2. Study area map (Katlang, district Mardan) (Khan et al., 2019)

Where Y_i the dependent variable representing farmers' perception of the climate change indicators measured on a three points likert scale. X_i the vector of independent variables in the study, while α_1 and α_2 are the cut points.

Empirical model

Based on previous studies and economic theories of climate change, farmers' perceptions of climate change in terms of perceptions of change in rainfall, temperature and incidence of pest and diseases were estimated (Asrat and simane, 2018). Dependent variable was farmers' perception, while the independent variables were age, education, farming experience, total monthly household income, family size, farm size, land ownerships status and nature of the land cultivated. The empirical model to estimate the perceptions of farmers regarding climate change is given.

$$Y_i = \delta_0 + \delta_1 X_1 + \delta_2 X_2 + \delta_3 X_3 + \dots + \delta_k X_k + \epsilon$$

More explicitly,

$$Pr = \delta_0 + \delta_1 (Age) + \delta_2 (Edu) + \delta_3 (HHS) + \delta_4 (FE) + \delta_5 (FS) + \delta_6 (LO) + \delta_7 (TI) + \delta_8 (NL) + \epsilon$$

Where;

Pr = The perception of the ith farmer about climate change

Age: Age of the ith respondent is a continuous variable and measured as number of years

Edu: Education of ith respondent is also a continuous variable and represents the number of schooling years of sampled respondents.

HHS: Household size of the ith respondent is a continuous variable and refers to the number of

persons in a family.

FE: Farming experience of the ith farmer, measured as number of years of farming spent by respondents in farming activities.

FS: Farm size of the ith respondent is a continuous variable denoting the total land operated by the sampled respondents measured in acres.

LO: land ownership of the ith farmers, a categorical variable comprising of three categories including i.e. i) owners ii) owner-cum-tenant and iii) tenants.

TI: Total monthly income of the ith respondent represents incomes from all sources earned during a month.

NL: Nature of land is categorical variable comprising of two categories including i) Rain-fed ii) irrigated.
E: random error term

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents

This part of the research deals with results obtained from data analysis of the study. This starts with explaining dependent variable and its determinant explanatory variables used in this study survey. Perceptions of the farmers were recorded on three point likert scale so the minimum perception was 1 (one) for low and the maximum recorded was 3 (high). The mean values of the perception variables indicated that farmers have concerns and perceived changes in the rainfall more followed by changes in temperature and incidence of pests and diseases, respectively. The summary results of the socioeconomic characteristics of the sampled respondents indicated the average age of 44.42 years, with average schooling and household size of 7.73

Table 1. Descriptive statistics used in the study

Particulars	Mean	Std. Dev.	Minimum	Maximum
Dependent variables				
Perception of rains	2.26	.54	1	3
Perception of temperature	1.84	.66	1	3
Perception of pest and diseases	1.38	.58	1	3
Explanatory variables				
Age (years)	44.42	10.41	32	74
Education (years)	7.73	4.74	0	16
Household size (members)	9.96	2.12	6	13
Farming experience (years)	27.90	10.58	12	52
Farm size (acre)	3.10	1.25	1.50	6.40
Land ownership	1.53	.69	1	3
Total income (Rs.)	53,598.03	13667.53	25,000	78,600
Nature of land (Rain-fed/irrigated)	0.39	0.49	0	1

Source: Survey data, 2019-20.

Table 2. Determinants of climate change perceptions

Independent variables	Perception of rain	Perception of temperature	Perception of pest and diseases
Age	-.0271 (.0409)	-.1665***(.0427)	-.1169***(.0443)
Education	.0522** (.0358)	.1349*** (.0359)	.1956***(.0493)
Household size	-.0918 (.0683)	-.1647**(.0723)	-.5082***(.1273)
Farming experience	.0697* (.0409)	.1172*** (.0424)	.2282***(.05032)
Farm size	-.0461 (.1566)	-.4869***(.1749)	-.8417***(.2132)
Land ownership	.1827 (.25633)	.6067** (.2819)	0.4196 (.2649)
Total income	.00003**(.00001)	0.00004** (.00001)	0.00002***
Nature of Land (1, rain-fed and 0, otherwise)	1.3765***(.3884)	1.403*** (.4112)	.1075* (.4510)
Cut ₁	-.2429 (1.223)	7.5415***(1.4073)	2.8504*(1.5401)
Cut ₂	2.442**(1.2445)	10.2359***(1.5987)	4.8368***(1.6187)
LR Chi(8)	46.62***	89.00***	72.19***
Pseudo R ²	0.2436	0.3786	0.3869
Observations	140	140	140

Source: Calculated by Author, 2019-20 Note: ***, ** and * represent significance level at 1%, 5% and 10% probability, respectively, Standard errors are presented in parenthesis

years and about 9.96 members, respectively. Average farming experience was 27.90 years having farm size of 3.10 acres, possessing land ownership of 1.53 with average total income of PKRs. 53,598.03 Nature of land was recorded with computed average value of almost 0.40, means most of the land was rain dependent in the study area. Our results are concurred by Ndambiri *et al.* (2012) where they mentioned that majority of the study respondents who perceived climate change had age between 31-60 years with higher farming experience.

Determinants of climate change perceptions: probit model estimation

Data in **Table 2** reveal that most of the socio-economic and demographic factors had a positive and significant influence on farmers' climate change perceptions. Age significantly affects farmers' perception of changes in temperature and incidence of pest and diseases indicating that the younger farmers had higher probability to perceive more changes in temperature and pest and diseases incidence compared to their older counterparts. However, the impacts of age in case of farmers' perception of changes in rainfall are non-significantly negative as validated by Hamilton and Keim (2009); Kim *et al.* (2011); Khan *et al.* (2019). Study findings indicated that increase in education level had a significant impact that higher the years of schooling, higher would be the perception of the climate change in terms of change in rainfall, change in temperature and incidence of pest and diseases. Educated section of the study area had wide range of knowledge about climate change. Education enables farmers' ability to access information, to comprehend, assess and react to any undesirable change and predict possible future repercussions. The results are in line with studies of Apata (2011); Kim *et al.* (2011); Mustapha *et al.* (2012);

Ndambiri *et al.* (2012); Ndambiri *et al.* (2013); Amdu *et al.* (2013); Akanda and Howlader (2015); Uddin *et al.* (2017). Impacts of household size on farmers' perception was non-significant negative in case of rainfall, while in case of temperature and incidence of pest and diseases was significantly negative indicating that farmers with small families perceive more changes in climate variables than large families and the results were consistent with Falaki *et al.* (2013); Oluwatusin (2014); Elum *et al.* (2017); Uddin *et al.* (2017). Farming experience has significant positive impact on farmers' perceptions regarding change in temperature and pests and diseases indicating that experienced farmers are more likely to perceive, understand and forecast climate change than inexperienced farmers because of more years of farming, more contact with extension services of the former than the latter which was confirmed by studies such as Hansen *et al.* (2004); Silvestri *et al.* (2012); Ndambiri *et al.* (2012); Montle and Teweldemedhin (2014); Roco *et al.* (2015); Sanog *et al.* (2017); Uddin *et al.* (2017). However, perceptions regarding rainfall were relatively insignificant.

Farm size had non-significant negative impact on changes in temperature and incidence of pests and diseases perception indicating. The study outcomes are consistent with Semenza *et al.* (2008); Sanog *et al.* (2017); Uddin *et al.* (2017); Khan *et al.* (2019). The study witnessed non-significant impact of farm size on rainfall perception. Land ownership had significant positive impacts on farmers' perceptions on temperature indicating that owner farmers were more likely to perceive changes in temperature than owner-cum-tenants and tenants because farmers with land ownership had greater tendency to climate change awareness than tenants due to the fact that produce-share-system exists here due to which tenants are not concerned too much about the climatic

change as supported by Roco *et al.* (2015); Elum *et al.* (2017); Sanog *et al.* (2017). However, the impact of land ownership had positive impact on perception of rainfall and incidence of pests and diseases. The significant positive relationship of total income with perception of climate change indicators of change in rainfall, temperature and incidence of pest and disease indicated that high income farmers perceive climate change more than low income farmers because former had more ability to access and use resources than the latter. The results were confirmed by Semenza *et al.* (2008); Akanda and Howlader (2015); Khan *et al.* (2019); Nizam (2013); Maddison (2006).

CONCLUSION

The study findings indicated that the impact of socioeconomic indicators on perceptions of changes in rainfall were significant for education, nature of land and total income. All socioeconomic indicators had significant impact on perception regarding changes in temperature and incidence of pest and diseases except impact of land ownership on incidence of pests and diseases perception. Socioeconomic conditions of the respondents affected their perception level which in turn affect the decision making sense of them regarding coping strategies against changing climate. For the same reason the government needs to increase climate and climate change awareness among farmers through different formal, informal and adult education programs i.e. training workshops, Farm Field Schools and access to climate information through electronic and print media. Moreover, the Agricultural Extension Agencies should bridge the farmer-media gap. Furthermore, the Government should not only bring pragmatic land reforms but also increase the opportunities to diversify farm income. Establishment of Farm Services Centers will help the farmers' ability to access and gather the weather, climate and Agricultural Extension Information.

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CONTRIBUTION OF AUTHORS

Sr. No.	Author's name	Contribution	Signature
1.	Muhammad Afnan Raza	Conducted the research work and prepared the initial draft of manuscript	
2.	Sana Ullah	Helped in statistical analysis and proof read the manuscript	