Pak. J. Agri. Sci., Vol. 56(x), xxx-xxx; 2019
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
DOI: 10.21162/PAKJAS/19.8089
http://www.pakjas.com.pk

COPING STRATEGIES OF FARMERS REGARDING THE IMPACT OF CLIMATE CHANGE IN RICE-WHEAT ZONE OF THE PUNJAB, PAKISTAN

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Pakistan is one of those countries which are victim of climate change and is already facing many problems like poverty and food insecurity leading to threats to agriculture expansion. Climate change is ahead of all these due to decreasing agriculture production prolonged water scarcity and declined income growth. Agriculture plays a big role in economy of Pakistan and climate change is matter of serious concern. The main objective of the present study was to find out the factors affecting the strategies of farmers regarding the impact of climate change in Punjab, Pakistan. Three districts from rice-wheat cropping zone (Narowal, Sialkot and Gujranwala) were selected randomly. A total sample of four hundred eight respondents was selected by systematic random sample technique. A well-structured interview schedule was used as research instrument for data collection. Collected data were analyzed statistically. In addition, descriptive and inferential statistics were applied for the data analysis. It was found that education level of the farmers was low in the study area. Most farmers had small land holdings and were used to self-cultivation. Mean area of wheat and rice was 7.31±6.06 and 6.25±5.60 acres, respectively. It was observed that long summer and short winter season and high temperature were the main perceptions of climate change in the study area. Industrial smoke, excessive felling of forests and human activities were also perceived as the factors leading to change in environment. A vast majority of the farmers observed that climate change had negative impact on crop production and annual income. It was also found that recommended varieties (2.58±0.72), applying more industrial pesticides (2.50±0.76) and practicing crop diversification (2.36±0.81), increased use of irrigation (2.19±0.89) and integrated farming system (0 2.15±0.91) were the major coping strategies for minimizing the effect of climate changes and these strategies had positive impact on crop productivity. Binary Logistic Model showed that increase in education, income, agricultural experience, contributes in to adoption of strategies to cope climate changes of farmers. It is recommended that farmers should use approved varieties, fertilizers and practice crop diversification. Investment on improved agricultural technology by government and other stakeholders are very necessary for agriculture to be able to cope with climate change.
Keywords: Agriculture, climate change, atmospheric heat, greenhouse gases, crop production.

INTRODUCTION

Climate variation means a change in weather within a specific period of time due to change in natural condition or human activities (Anon, 2007). It also means a change in climate lasting for decades or longer as an outcome of human activity that changes atmosphere, greenhouse gases emission (Oxfam International, 2009; IPCC, 2007a). Present atmospheric heat is due to human activity which leads to increase many gasses in the atmosphere. Half of the gasses (e.g. CO_2) are absorbed by sea and tree and rest are mounted up in atmosphere (Afzal and Akhtar, 2013).
Climate change is one of the biggest challenges in all over the world. The average annual temperature of earth has risen 0.82°C from 1880 to 2012 (Hartmann *et al.*, 2013). Temperature of earth had been warmed on an average by about warmest from 1990 to 2000s (Waston, 2010). The heat of world seas has increased and global mean sea level has gone up by 225 mm from 1880 to 2012 (Church *et al.*, 2013). Most of the nations are suffering from rising temperature, melting of glaciers, rising of sea level causing floods leading to increased risk of drought or dangerous floods and these have badly affected the economic sector of many countries of the world. The weather change of South Asia has led to change in water resources, food health, biodiversity, forestry and socio-economic sectors (Field, 2014).
Overall decline in production is supposed between 3 to 16% but developing countries may face 25% decrease in product by 2080. European countries will experience a much milder or even positive average effect, ranging from a 8% increase in productivity to a 6% decline. South Asian developing countries like India may face decrease of product by 3 to 40% during the same period (Mahato, 2014). Current variations in climate have affected the people of world as it is matter of change in climate and for other a matter of life and death. It is a reality that developing countries have not increased annual carbon dioxide emission but they are suffering more from its effect (Daze, 2011; Van Aalst, 2006).

Agriculture sector is important which provides raw materials to industry and contributes 19.8% in GDP and it also absorbs 42.3% of country's total labour force. Agriculture growth depends on climate temperature but precipitation may affect agricultural product commodity price and economic growth. The policy makers have shifted to develop projects of agriculture during past years as it will increase the foreign exchange reserve. The small farmers are facing problems and they have been figured in lower to middle range of economy trying to provide the food requirement with current rate of development imagine to slip to the lower ranged economy having ability to provide the food needs of population 2030 (GOP, 2017).

In Pakistan two cropping seasons namely Rabi and Kharif are famous. Rabi crops are grown from November to April and Kharif crops are grown from May to October and these two seasons shape the agriculture economy of Pakistan. Wheat which is Rabi crop, was cultivated on 9.05 million hectare in 2016-17 with total yield of 25.750 million tones. During Kharif season rice was cultivated on 2.72 million hectares in 2016-17 with yield of 6.849 million tones. Wheat and rice yield is important for food security and wheat accounts for 9.6% of total value added in agriculture. The land under production of rice and wheat is mainly unfavorable and this un-favorability is due to water supply, variation in monsoon demonstration and government plan for subscribed prices of crops and support price for raw material (GOP, 2017).

Rice wheat system is one of the main cropping systems of Punjab Pakistan. The rice crop is grown well on puddle part of land, whereas, wheat is grown well on drained land. The well-developed puddling operations supports water retention and weed control. The compacted soil leads to water logging for wheat moreover the traditional land preparation after rice harvesting results late wheat sowing. May and June are important for rice transplanting and October-November have significance for rice harvesting. The rice transplantation and harvesting is fluctuated by monsoon season. The wheat of irrigated regions is affected from temperature fluctuation such as sudden rise in day temperature in February-March (milky stage) after a long cold and wet spell cause shrinking of grains. This biological cycle affect the grain size, weight and starch contents leading to decrease in grain yield. However, crop production is not affected due to precipitation as water supply is sustainable because of canal irrigation until prolong drought grips. Wheat and rice of the main crops largely being consumed as staple food and food security mainly revolve around both the crops (GOP, 2013).

Agriculture sector is guaranteeing food security and alleviating poverty. Atmospheric heat increases in evapotranspiration causing increase in irrigation need and increasing warming pressure on crop. The introduction of short period crop cultivars and arrangement in sowing time may reduce the negative effect of predicted weather risk. The low land fertility of semi-arid and dry land of Pakistan particularly Sindh and Balochistan is victim of climate change as low rain fall increases evapotranspiration resulting drought. Increase in 1°C in heat may decrease 5-7% wheat production (Aggarwal and Sivakumar, 2011). Another report indicates that wheat production is decreased up to 6-9% in semi-arid and sub humid zone of Pakistan but its production increased in humid region (Sultana and Ali, 2006). An increase in heat by 1.5-3.0°C may reduce wheat production by 7-21% in Swat district, KPK, Pakistan whereas wheat production may increase by 14-23% in Chitral, Pakistan (Husnain and Mudassar, 2007).

In addition to increase in temperature, low rainfall may affect crop yield adversely. Low rainfall results in low production in cereals, fruits and vegetable. The agricultural and livestock farmers use different strategies to overcome the climate change risk. These adoption measures are taken for adjustment in sowing time of different crops to avoid weather change risk. They are also making efforts to use stress–tolerant crop varieties to cover the climate change risk (Smit and Skinner, 2002). Adoption measures e.g., sowing dates, fertilizer use efficiency, irrigation system, crop varieties, irrigation numbers and cultivation methods significantly affect the crop productivity (Challinor *et al.*, 2014). However, farmers are facing difficulties in using these adaptation practices (Porter *et al.*, 2014). These adoptive measures may reduce the influence of climate variation.

The climate change impact on natural and socio-economic segment is important to study which would help to understand and identify the intensity and impact on global climate change. Studies on perceived local knowledge and adoptive strategies at household and community level would provide the basis to understand the concepts and methods to assess the impact of climate change. Therefore, the main objective of the present study was to find out the factors affecting the coping strategies of farmers regarding the impact of climate change in rice-wheat zone of the Punjab, Pakistan.

MATERIALS AND METHODS

Multi-stage sampling technique was applied for data collection. At the first stage three districts (Narowal, Gujranwala and Sialkot) were selected randomly from rice-wheat crop zone of Punjab, at the second stage three tehsils (one tehsil from each district) such as Shakargarh (Narowal district), Noshara Virka (Gujranwala district) and Pasroor (Sialkot district) were selected randomly, at the 3rd stage six Union Councils, 2 from each selected tehsil (UC-90 & UC-91 from Tehsil Sakargarh, UC-78 & UC-81 from Tehsil Noshara Virkan and UC-19 & UC-21 from Tehsil Pasroor) were selected randomly, at the 4th stage 24 villages (four from each UC) were selected randomly and at the last stage a sample size of 408 farmers (17 farmers from each village) were selected by using systematic random sampling technique.

Data were collected with the help of a comprehensive interview schedule and analyzed by using SPSS-22 software. Descriptive analysis (frequency, percentage, mean, standard deviation) and linear regression model were used for data analysis. In the present study, a binary logistic model was applied to observe the factors influencing the adoption of coping strategies applied by the farmers in the study area. Similar method was applied by Huong *et al.* (2017) to explore the farmers' awareness and adaptive response about climate change.

RESULTS AND DISCUSSION

Age**:** According to age, the respondents were assembled into three classes: (I) 1st category belonged to young farmers (Up to 40), (ii) 2nd category belonged to middle-aged (>40-50), and (iii) 3rd belonged to old (>50). The information (data) in this regard are displayed in Table 1, which shows that 29.4% of the chosen agriculturists (farmers) were of age group (up to 40), while 34.6% and 36.0% of the chosen ranchers (farmers) belonged to middle age group (41-50), and old (over 50) group, respectively.

It can be inferred from the obtained results that the majority of the chosen growers were of middle and old age groups, while about one-third of them were of young age. This alludes that the farmers in the research area were more experienced. Due to this experience in the field, they were better able to adapt themselves according to the changing circumstances. They were familiar with the changing trends of climate change due to the global warming. The results of the present investigation are as per those of Fawole (2006) and Ofuoku *et al.* (2008) who found that the greater part of the selected farmers belonged to middle and old age groups respectively.

Education**:** Around 33% of the chosen agriculturists were uneducated, while a noteworthy extent (43.9%) of the selected farmers had the primary-middle level, though just 13.2% of the respondents were with matriculation (Table 1), and 10% of them had above matric level education. The discoveries of the information demonstrated that the education level of the agriculturists was low. The above outcomes are comprehensively upheld by Akhtar (2011). Whereas, the conclusions are opposing to those of Arshad (2009) who concluded that a large majority of farmers were illiterate.

Income**:** The Table 1 uncovers that 33.3% of the selected farmers had up to Rs. 30,000 monthly income from all sources, while 39.2% of the chosen peasants had Rs. 30,001-40,000 monthly income and 27.5% of them had above Rs. 40,000 monthly income. The outcome of the present research are contradictory to those of Mehmood (2011) who told that around 32% farmers had annual income less than Rs. 200,000 per annum from all sources. While around 23, 31 and 14.1% sampled farmers were having annual income of Rs. 200001 to 300000, 300001-400000 and more than Rs. 400000, respectively.

Family type**:** It has been observed that around 40% of the selected farmers were living in nuclear family system, while less than a half (48.3%) of the selected farmers were living in joint and extended (12.3%) family system (Table 1). According to Mansoor (2008), mostly Pakistani population was living in joint family system.

Family size**:** It is assumption that large family size is normally associated with a higher labour endowment, which would enable a household to accomplish various agricultural tasks. It was observed regarding family size that 40.4% of the selected farmers had up to five family members, while 37% of the respondents had 6-10 family members, and 22.5% of the respondents had above 10 family members (Table 1).

Table 1. Socio-economic characteristics of the selected farmers (n=408).

Socio-economic characteristics	Frequency	Percentage
Age (years)		
Up to 40	120	29.4
41-50	141	34.6
Above 50	147	36.0
Education		
Illiterate	134	32.8
Primary-Middle	179	43.9
Matric	54	13.2
Above Matric	41	10.0
Monthly income (Rs.)		
Up to 30000	136	33.3
30001-40000	160	39.2
Above 40000	112	27.5
Family type		
Nuclear	161	39.5
Joint	197	48.3
Extended	50	12.3
Family size (Nos.)		
Up to 5	165	40.4
6-10	151	37.0
Above 10	92	22.5

The number of years completed by a farmer working on the farm and cultivating, harvesting, and irrigating a number of crops is called his farm experience. Longer cultivating background suggests aggregated cultivating learning and expertise, which adds to use of agrarian technologies (Tadesse, 2008). The respondents were divided into three groups based on their farm experience: (i) up to 20 years, (ii) 21-30 years, and (iii) >30 years. Data presented in Table 2 depicts that 32.4% of the respondents had up to 20 years of farming experience, while 35.5% of the selected farmers had 21-30 years of farming experience, and 32.1% of them had above 30 years of working experience. Lewis (1997) was of the view that longer duration of experience on the part of the farmer implies that he is exposed to the latest and modern means of cultivation. He can handle the climate changes more effectively as compared to other farmers. Edeoghon *et al.* (2008) also reported that 32.20% of the respondents had farming experience of about 20 years which is very much similar to the findings of our research.

Table 2. Farming experience (n = 408).

Farming experience (No. of years)	Frequency	Percentage
Up to 20	132	32.4
21-30	145	35.5
Above 30	131	32.1
Total	408	100.0

Size of land holding implies the measure of farm ran by single agriculturist and his family for crops and animals' production. There is more tendency to adopt larger farm while effectively utilizing the innovative technology (USDA, 2007). There were three categorizes of the farmers who were concerning about land holding size: (i) up to 5 acres of land, (ii)>5- 10 acres of land, and (iii)>10 acres of land. Around 34 of the chosen agriculturists had up to five acres of land, while 45.3% of the chosen agriculturists had between 5 to 10 acres of land (excluding end points), and 20.8% of them had over ten acres of land (Table 3). Mean size of land holding was 8.79 acres of land with standard deviation of 7.09 acres of land. So, mostly farmers had >5-10 years acres of land. Comparable discoveries were accounted for by Akhtar (2011).

Table 3. Classification of sampled farmers concerning to land holding size.

Size of land holdings (acres)	Frequency	Percentage
Up to 5	138	33.8
>5-10	185	45.3
Above 10	85	20.8
Total	408	100.0

Mean = 8.79 S.D. = 7.09

In the study area, wheat and rice were the major crops. Among the Rabi season crops wheat is predominant, which was sown on 9.05 million ha in 2016-17 with a yield of 25.750 million tons. Among the Kharif season crops rice is a vital crop, which yielded 6.849 million tones out of 2.72 million ha in 2016– 2017 (Govt. of Pakistan, 2017).

Table 4 reveals that 38.7% of the selected farmers had up to 4 acres reserved for wheat cultivation, while 38.7% of the selected farmers had >4-8 acres reserved for wheat cultivation, and 22.5% of the selected farmers had above 8 acres reserved for wheat cultivation. So, a considerable proportion of the sampled farmers had up to eight acres for wheat cultivation.

About 44.4 % of the selected farmers had up to 4 acres reserved for rice cultivation, while 36.5% of the selected farmers had >4-8 acres reserved for rice cultivation and 19.1% of the selected farmers had above 8 acres reserved for rice cultivation. It is clear from the above mentioned findings that mostly selected population reserved up to four acres land for rice crop. Mean area of wheat (7.31±6.06) was high as compared to rice (6.26±5.60) in the study area.

Table 4. Classification of the selected farmers concerning to area under wheat and rice crops during the previous one year.

Area (acres)	Wheat		Rice	
	f	%	*f*	%
Up to 4	158	38.7	181	44.4
>4-8	158	38.7	149	36.5
>8	92	22.5	78	19.1
Total	408	100.0	408	100.0
	Mean area=7.31, SD= 6.06		Mean area=6.25, SD= 5.60	

Table 5 represents the rank order of farmers' perception about causes of climate change. Table showed that the industrial smoke was the cause of climate change (2.64 ± 0.69) and it was ranked 1st on the basis of farmers' perception about the causes of climate change, while the excessive felling of forests, leads to change in environment (2.57 ± 0.68) and human activities were causing changes on the earth's climate (2.51 ± 0.72) were ranked 2nd and 3rd, respectively. Whereas, the burning of waste material was the cause of climate change (2.46 ± 0.79). The excessive use of coal, fuel, oil, and gas on domestic and commercial basis also leads to change in climate (2.44 ± 0.79) and the excessive use of sub-soil water in agriculture causes the climate to change (2.37 ± 0.87) were ranked 4th to 6th, respectively on the basis of farmers' perception about the particular causes of climate change. Huertas (2015) demonstrated the similar results. According to his research findings, cutting of forests, industrial smoke, and human efforts are the real cause of climate change.

Table 5. Means, standard deviation and rank order of farmers' perception about causes of climate change.

Causes of climate changes	Weighted score	Mean	S.D	Rank
The industrial smoke is the cause of climate change	1077	2.64	0.69	1
The excessive cutting of forest, leads to change in environment	1047	2.57	0.68	2
Human activities are causing changes in the earth's climate	1026	2.51	0.72	3
The burning of waste material is the cause of climate change	1002	2.46	0.79	4
The excessive use of coal fuel, oil and gas on domestic & commercial basis also leads to change in climate	997	2.44	0.79	5

The excessive use of sub soil water in agri. causes which leads to change in climate	965	2.37	0.87	6

Scale: 1 = Disagree, 2 = Neutral, 3 = Agree

Table 6 represents the farmers' perception about the consequences of climate change. It was observed that majority of the respondents (87.5%) reported that elevated temperature, more rainfall (58.6%), more humidity (72.3%), more fog during winter (83.8%), more wind storms during summer (74.0%), smog (87.0%), shorter winter season (93.9%), and longer summer season (94.6%) were the major consequences of the climate change. The results presented are very much in line with the findings of (Watson, 2010), high temperature (Farooq *et al.*, 2004), decline in rainfall (Osada *et al.*, 1973) and humidity (Lyngdoh and Baishya, 2010).

Table 6. Farmers' perception about consequences of climate change (n = 408).

Consequences of climate change	Yes		No	
	f	%	*f*	%
High temperature	357	87.5	51	12.5
More rainfall	239	58.6	169	41.4
More humidity	295	72.3	113	27.7
More fog during winter	342	83.8	66	16.2
More wind storms during summer	302	74.0	106	26.0
Smog	355	87.0	53	13.0
Shorter winter season	383	93.9	25	6.1
Longer summer season	386	94.6	22	5.4

It is obvious from the findings that rise in temperature will reduce the productivity of the crops. Exposure to high temperature will reduce the growing period, crop will mature earlier and resultantly there will be the low production. The regions where temperature is already high, the further increase in temperature will have devastating effect on the crop yield (IPCC, 2007b). The results in regard to agriculturists' assessment about the effect of environmental change on edit efficiency are given in Table 7, which shows that crop production in general is not enough to meet the needs of the people (2.72 ± 0.62) was ranked 1st on the basis of farmers' opinion about the impact of climate change on the crop productivity, while the statement 'If our agriculture products remain decreasing, we shall have to face food shortage in the future' (2.72 ± 0.53) and Increased ratio of salt in fertile land leads to low crop production (mean = 2.68 ± .58) were ranked 2nd and 3rd, respectively. Whereas, the irregular seasons have badly affected the crop productivity (2.65 ± 0.64), and (2.56 ± 0.76) were ranked 4th to 5th, respectively on the basis of farmers' perception about the impact of climate change on the crop productivity. Similar findings were presented by FAO (2009).

Table 8 unveils the farmers' perception about the coping strategies adopted by the farmers regarding climate change. It was observed that 'grow recommended varieties now than past decades' (2.58 ±0.72), Use of more industrial pesticides now than in past decades (2.50 ±0.76) and Practicing crop diversification (2.36 ±0.81), Increased use of irrigation (2.19 ± 0.89) and Integrated farming system (2.15 ± 0.91) were the major coping strategies ranked 1st to 5th, respectively. While, zero tillage (1.66 ± 0.87), Use of drought tolerant varieties (1.61 ± 0.43), Use of salinity tolerant varieties (1.61 ±0.50), Practice mixed cropping more than past decades (1.52 ± 0.61), Cultivating short duration crops (1.36 ± 0.68) and Practicing inter cropping (1.35± 0.42) were ranked 6th to 11th, respectively.

Table 7. Farmers' opinion about impact of climate change on crop productivity (n = 408).

Impact of climate change on crop productivity	Mean	S.D.	Rank
Crop production in general is not enough to meet the needs of the people	2.72	0.62	1
If our agriculture products remain decreasing, we shall have to face food shortage in the future	2.72	0.53	2
Increased ratio of salt in fertile land leads to low crop production	2.68	0.58	3
The irregular seasons have badly affected the crop productivity	2.65	0.64	4
The intensity of season has led to decrease the nutrient of crops	2.56	0.76	5

Scale: 1 = Disagree, 2 = Neutral, 3 = Agree

Table 8. Means, standard deviation and rank order of farmers' perception about coping strategies being adopted by the farmers regarding climate change.

Coping strategies	Mean	S.D.	Rank
Grow recommended varieties now than past decades	2.58	0.72	1
Use of more industrial pesticides now than in past decades	2.50	0.76	2
Practicing crop diversification	2.36	0.81	3
Increased use of irrigation	2.19	0.89	4
Integrated farming system	2.15	0.91	5
Zero tillage	1.66	0.87	6
Use of drought tolerant varieties	1.61	0.43	7
Use of salinity tolerant varieties	1.61	0.50	8
Practice mixed cropping more than past decades	1.52	0.61	9
Cultivating short duration crops	1.36	0.68	10
Practicing inter cropping	1.35	0.42	11
Moved to Non-farm activities	1.35	0.69	12
Soil conservations techniques	1.32	0.46	13
Agro forestry	1.29	0.61	14
Using multiple cropping pattern	1.28	0.58	15

Water conservations techniques	1.27	0.49	16
Crop insurance	1.16	0.46	17

Scale: 1 = Disagree, 2 = Neutral, 3 = Agree

Whereas, moved to non-farm activities (1.35 ± 0.42), soil conservations techniques (1.32 ± 0.46), agro forestry (1.29 ± 0.61), using multiple cropping pattern (1.28± 0.58), water conservations techniques (1.27 ± 0.49) and crop insurance (1.16 ± 0.46) were ranked the lowest 12th to 17th, respectively. Ullah (2017) and Fadina and Barjolle (2018) also recommended improved seed varieties, chemical fertilizers and pesticides to reduce the effects of climate change.

***Factors affecting coping strategies regarding the impact of climate change*:** The impact of study variables on coping strategies about weather variation has been studied by using the logit model (Table 9). The value of log-likelihood (-2LL) is 174.26 indicates that the effect of independent variables through the purposed model is significant and hence model estimation or fit of the model has been improved. There are two further statistics required to explain the features of the model. First is Cox and Snell R^2 whose value is 0.609; indicates that 61% of total variation is explained by the independent variables in the chosen model and 39% by the other variables and/or by chance. Second is Nagelkerke R^2 whose value is 0.818; indicates that 82% of total variation is explained by the independent variables in the chosen model and 18% by the other variables and/or by chance. Both of these measures technically called pseudo R^2 and its value could hardly be tested through inferential approaches of the statistics (Menard, 2000). Resultantly, it could not be considered the good measure of goodness of fit for the purposed model (Hosmer and Lemeshow, 2000).

Table 9. Binary Logistic Model.

Variables	B	Wald	Sig.	Exp(B)
Age	-0.828	3.197	0.074^{NS}	0.437
Edu	0.549	7.885	0.005**	1.731
Income	0.575	4.633	0.031*	1.777
Family type	0.742	4.462	0.035*	2.101
Experience	1.934	13.907	0.000**	6.914
Size of land holding	0.224	0.564	0.453^{NS}	1.250
Impact	-1.797	11.871	0.000**	6.158
Constant	-14.830	64.779	0.000**	0.000

Dependent variable: Adoption of coping strategies, ** = significant at < 1%; * = significant at < 5% and NS = Non-significant.

***Age of selected farmers*:** It was found that in the study area the **i**ncrease in age contributes in decrease adoption of coping strategies to cope climate changes by the selected farmers. Odds ratio for the variable age is 0.437; explained that each one-unit increase in the age will likely to decrease 0.437 times chances for the adoption of coping strategies to cope climate changes was improved. The P-value indicates that there is non-significant relation of age with the adoption of coping strategies to cope climate changes in the study area. These results are opposite to those of Ali and Erenstein (2017) who reported that age of farmer were having positive and significant impact on the utilization of adaptive techniques.

***Education of selected farmers*:** Increase in education significantly contributes in adoption of coping strategies to cope climate changes of selected farmers. The odds ratio for the explanatory variable education is 1.731 and it tells that if the education of farmers will be enhanced by one-unit (a year of further schooling) then there are 1.731 times chances for adopting the coping strategies towards climate change will likely to be improved. Similar results were found by Ali and Erenstein (2017) who conluded that education level of farmers have positive and significant impact on the utilization of adaptive techniques for climate changes.

***Income of selected farmers*:** The variable income indicates the collective income of the selected farmers from all legitimate sources. The estimated coefficient of income is positive and significant. It indicates that there is a positive relation between adoption of coping strategies and the income of farmer. The odds ratio of income is 1.777 and it explained that for each unit increase of farmer's income, there will be 1.78 times more chances for adopting the coping strategies by farmer. Bryan *et al.* (2009) also found that the farmers' income influence on their adoption level of coping strategies against climate changes.

***Agricultural experience of farmers*:** Agricultural experience of farmers contributes in adoption of coping strategies to cope climate changes of selected farmers. The odds ratio of variable named "experience" is 6.914 which explained that for each unit increase in the agricultural experience, there are 6.914 times chances that adoption of coping strategies towards climate changes will be improved. The positive sign shows that experienced farmers had more adoption of coping strategies to cope climate changes. Similarly, the conclusions of present research are in accordance with those of Adger *et al*. (2003) who found that the farmers' experience had positive relation with adoption of coping strategies related to weather variation.

***Size of land holding*:** It is found that the **s**ize of land holding had no impact on adoption of coping strategies against climate change in the study area. The results of present study are contradictory to those of Abid *et al*. (2015). They found that size of land holding and adaptation to the climate change were having positive relationship.

***Impact*:** The positive and significant coefficient of variable "impact of climate change" implies a negative relation between impact of climate change on crop productivity and adoption of coping strategies towards climate change. The value of its odds ratio is 6.158 indicates that per unit increase in the impact related to agriculture likely to enhance the adoption of coping strategies against climate change. So, it is clear these findings that coping strategies reduced the effects of climate changes on crops.

The binary logistic model has been also used by Abid *et al*. (2015) in analyzing their research data. Their findings told that the choice of farmers to adopt coping strategies towards the climate change were affected by the education level of farmers, family size, land holding, information about weather forecasts and availability of agriculture extension services.

Conclusions**:** It is concluded that education level of the farmers was low in the study area. It was noted that most farmers were having small land holding with self-cultivation. It was revealed that long summer and short winter season and high temperature were the major perceptions concerned for the consequences of climate change in the study area. It was found that industrial smoke, excessive cutting of forest and human activities were the major causes of climate change in the study area. A vast majority of the selected farmers reported that climate change affected negatively their crop production and productivity. So, majority of the farmers were in view that their annual income is decreased due to climate change. A very small proportion of the farmers had knowledge about any agricultural institution working for climate change in the Punjab, Pakistan. It was found that 'growing recommended varieties, use of more pesticides and practicing crop diversification, increased use of irrigation and integrated farming system were the major coping strategies for controlling the effect of climate change. Bivariate analysis showed that farming experience and coping strategies is negatively associated with the impact of climate change on crop productivity.

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