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What shapes Farmers' Awareness? A Case Study of Influencing Factors in Rural Areas of The Punjab

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Abstract: *The study examined the awareness of the farmers and its determinants of climate change in the Punjab province. The objective of the study is to explore the factors which are affecting farmers' awareness which is pre-requisite condition to cater climate change. To meet the objective of the study, data from the Central and Southern Punjab was collected by applying multi-stage sampling technique. The study collected the data with the help of structured questionnaire where 30 percent the farmers from the sample size, were interviewed face to face. The descriptive statistics shown the awareness of the farmers, age, education, experiences and other farm specific characteristics were included. To draw the empirical results, binary logistic regression was applied. The study results indicated about the different trends of the about the Farmers' awareness regarding climate change indicators. The study revealed that age, education and assets of the farmers have positive relationship with the farmer's awareness of climate change.*

Keywords: Climate Change Awareness; Logit model; odds ratio; agriculture

1. Introduction

Pakistan has been facing climate repercussions because of continuous industrialization and geopolitical situation which is leading towards adverse condition (Usman et al., 2023). Impact of climate change on Pakistan is due to many reasons which are its geographical location, demography and variety of climatic conditions (Ahmad et al., 2024). According to the IPCC in 5th assessment report presents that average temperature may rise between 0.3 to 4.8 (Sakashita et al., 2017). The studies indicate that variation in climate change has impacted the most vulnerable sector which is agriculture sector in such a way that erratic rainfall and increased temperature has put a dent on the food security and natural resources of the household and communities (Aqib et al., 2024; Buontempo et al., 2020). Further, increasing temperature and water mismanagement are giving impetus to food insecurity and lower income levels of farmers. Climate change causes droughts, floods and rising temperature leads towards the production losses and compromise the income level of the farmers especially in the rural areas (Ricciardi et al.,2018). It has a multifaceted impact as it affects not only our lives but also our income sources (Chevuru et al., 2023). It is the reason for declining agricultural cereal crop production up to 30 percent

such as wheat, maize and rice (Rosegrant et al., 2013; Ministry of Finance, 2022; Parry et al., 2005). All the above reasons lead toward low-income level and consumption level of the farmers.

These factors have influenced the agriculture sector to adapt different methods and techniques to cater the climate change problems for their productivity increase (Abbas et al., 2019). In agriculture sector, determinants of farmers' awareness of climate change have increased the adaptation techniques (Ricart & Rico, 2019). So, the farmers have to become well aware and adapt management strategies to become resilient in the long run to cater climate change (Abid et al., 2016). This becomes evident that change in crop and variability in climate has serious indication for the household to have awareness and alternate strategies in production is paramount in this context (Aqib et al., 2024). That is why, the objective of the study is to analyze the determinants that affects awareness of the farmers of climate change in Pakistan.

As mentioned earlier that climate change is a double-edged sword and it has impacted not our health but also our income, satisfaction and happiness. According to the World Health Organization defines the "quality of life is an individual's perception of their position in life in the context of the culture and value system in which they live in relation to their goals, expectations, standards and concern" (WHO, 1995, p. 1405). These indicators are sometimes overestimating the utility theory (Hirschauer et al. 2015), which alters the perception of people (Gowdy, 2008). It is often observed that many studies use perception and awareness interchangeably, but these two concepts are entirely different (Ahmed & Haq, 2019; Madhuri & Sharma, 2020; Mustafa et al., 2023). Awareness is a broader term as compare to perception. According to Britannica, Perception is regarded as sensory information. Whereas, awareness of the farmers to climate change is the recognition, understanding and experience of the intricacies of the impact of climate change on agriculture sector. That is why, awareness of farmers regarding climate change is imperative for the research purpose to foster the farmers and their awareness to adapt suitable techniques as management strategies in their production process to offset the negative impact of climate change.

Farmers' awareness of climate change paves the way to become resilient to climate vagaries. It is considered as bottom-up approach to create awareness among the farmers. Farmers have awareness regarding climate change but extent of this awareness is unknown and its determinants can measure the extent of awareness level (Tesfaye , 2016). Some farmers perceive that climate change have no impact and they are at denial stage of its happening. Therefore, they are not eager to adapt any technique (Ahmed & Haq, 2019). While other fraction of farmers believes that climate variation is happening and they do apply the suitable techniques to dilute the negative impact of climate variation (Usman et al., 2023). Moreover, the studies indicated the age and climate change are inversely related (Assefa et al., 2024). Similarly, lack of education and experience are also play negative role in CCA (Ali et al., 2021; Ibrahim et al., 2015; Mustafa et al., 2023).

Climate change negatively impact the agriculture sector but the intensity of the adverse impact is versatile beyond the geographical borders of any country and region wise as well (Nguyen & Scrimgeour, 2022). Similarly, its impact also has different effect on the farmers who has different attributes. There is strong nexus between farmers awareness and CCA. Farmers with proper awareness and planning may adopt the suitable techniques and improve their income level while poor planning and denying the CCA may invite the adverse impact of climate change. So, determinants of farmers play a significant role in this regard. Farmers qualities like, his power of diversification, awareness of climate change, education, credit facilities, lack of infrastructure and meagre interest in forecasting the devastating events occurring in near future which are hindrance in their good production are the factors which affect their output in agriculture sector. As a result climate change is pasting a serious threat to agriculture sector (Jabbar et al., 2023; Ahmad et al., 2024).

In the Pakistan, agricultural share in GDP is 22.9 percent and shown higher yield in the Rabi season but Kharif season was affected by flooding and overall growth was recorded 1.55 percent. It gives

opportunity to the people to get employment near 37.4 percent of the work force. But climate change is disrupting the food availability, reduction to food access and its quality. Increase in temperature is another epitome of the climate change which affects the crop patterns. Erratic rainfall is an impediment in the agricultural yield (Jabbar et al., 2023). Pakistan is struggling hard to mitigate the cataclysmic impacts of climate change but there is still a huge gap between the policy making and its implementation. Lack of initiatives from the Government and low monitoring of GHGs emissions is negatively contributing in agricultural production. While agriculture itself is the second largest contributor of the GHGs emission (Ministry of Finance, 2022). Where the countries with proper CCA to manage the climatic variation have higher agricultural yield as compare to improper utilization of CCA (Hussain, 2019). This research is aimed to contribute to enhance farmers' understanding and CCA. This study will be useful for the farmers and policy makers to support climate change knowledge and apply in agriculture sector.

According to the Theory of Planned Behavior, climate change becomes the attitude of the farmers which give impetus to adopt the management strategies as farmers are inclined towards the adaptation plans. They have no scientific reasons to adopt management strategies but to accept social values and local communities interactions and build perception regarding climate change (Nguyen & Scrimgeour, 2022; Ricart & Rico, 2019). Moreover, they have their personal point of views and literature also pointed out that there is a gap between the scientific measures and personal perceptions of the farmers regarding climate change(Abid et al., 2016; Chevuru et al., 2023). There are numerous studies which have covered the farmers' awareness of climate change in Pakistan (Abid et al., 2016; Mekonnen et al., 2021; Belay et al., 2022; Sabillón et al., 2022; Ahmad et al., 2024; Khan, 2012; Mustafa et al., 2019, 2023). These studies have indicated that farmers are aware that climate change has impacted their income level adversely and food security of the farmers (Abid et al., 2016; Alvi et al., 2021; Parry et al., 2005). There are some studies which are directing that there is lack of knowledge on farmers' side (Belay et al., 2022; Usman et al., 2023, 2023). But on the other side, decisions of the farmers solely depends upon the farmers awareness and their available resource to build the perceived behavioral control to assess that they can implement management strategies (Ali et al., 2021; Assefa et al., 2024). Further, adaptation is locally developed to cater the climate change and farmers fulfill this gap with their own perceptions and awareness of climate change (Ricart & Rico, 2019). So, it is worth mentioning that without understanding the determinants of farmers' awareness of climate change, it is difficult to cater climatic vagaries and its catastrophic impacts. It is necessary to increase the understanding and farmers' knowledge and awareness.

The study evaluates the determinants of farmers CCA variability in the context of Pakistan. For this purpose, the sampling technique that is used is Heckman probit sample selection model with two step procedure is utilized to address the selection bias (Heckman, 1976). There are also many other studies which have applied the same technique (Maddison, 2006) and (Morton, 2007). The studies examined the factors affecting CCA in first step and second step was taken to adapt new management strategies. Maddison (2006) applied two step procedure in Africa but this study will replicate the technique in the Pakistan context.

The study will carry its objective in a way to find out, during decision making process, the correct selection bias (Heckman, 1976). It further elaborates the factors which determine the farmers' CCA. So, that farmers would adapt suitable techniques to mitigate the impacts of climate change on agriculture sector as well as their income and food security level. Other segments of the studies are background of the study, conceptual framework, methodology and results, discussion and policy recommendations.

2. Conceptual Framework

CCA is affected by many factors and it can be framed into three categories which are farm and farmers

specific characteristics and institutional characteristics. Farm specific characters are location (Aqib et al., 2024), landholding (Saguye, 2016), and crop income (Abid et al., 2016). Similarly, famers specific characteristic are education, experience and access to extension service (Mustafa et al., 2023), farmer' organizations (Bachke, 2019), marketing access (Riley, 2008). Intuitional factors are access to credit facility (Wang et al., 2012) and member of organization (Huang & Liang, 2018). These factors affect the farmers awareness and determine the adaptation techniques. For example, (Assefa et al., 2024) stated that farmers with awareness to climate change had maximum probability to adapt management strategies to cater the adverse impact of the climate change. Furthermore, factors are very important so that farmers could get benefit from this by adapting different techniques to fulfill the need of time.

Table 1 Definition of Variables

Variables of the Study	Definition of the Variables	Expected Sign
Awareness *(Li)*; dependent variable	1 if farmers aware of climate change; 0 otherwise	
Education *(X_1)*	Years of Formal schooling	±
Experience *(X_2)*	Years of Experience in Farming	±
Family Size *(X_3)*	Number of Household Members	±
Distance from market *(X_4)*	Distance from Market	±
Size of Landholding *(X_5)*	Acre	±
Occupation *(X_6)*	Occupation	±
Farm Type *(X_7)*	Farm type (Lease, Own/ tenancy) 1 if farmer has own land; 0 otherwise	±
Farm Cooperation *(X_8)*	1, if farmer cooperate, 0 otherwise	±
Member Organization *(X_9)*	1, if farmer is member of organization; 0 otherwise	±
Access to Credit *(X_{10})*	1, if farmer has access to credit facility; 0 otherwise	±
Marketing of Produce (Bardana) *(X_{11})*	1, if farmer has access to marketing of produce; 0 otherwise	±

Source: Own illustration based on past studies.

3. Material and Method

3.1. Research Design

The study applied a quantitative approach by structuring a well-designed questionnaire for collection of the data. Five multi-stage sampling technique is applied. At first stage, area for the study was the Punjab prov selected. At second stage, the Southern Punjab and the central Punjab is selected. The districts from each zone were selected at stage third and fourth stage was to select union councils from the rural area at random basis. The last stage was to select farmers from the selected union councils. The total number of the sample size was 368 which was collected by using purposively multi-stage sampling technique. the questionnaire was developed in both English and Urdu languages to make it understandable for the respondents.

Table 2 field survey respondents

Zone	Districts	Tehsils	Total Number of UCs	Selected farmer From each UC	Total number of Farmers
Central Punjab	Lahore (5) Sheikhupura (5) Toba Tek Singh (4) Hafizabad (2)	Shalimar Sharqpur Kamalia Pindi Bhattian	18 9 11 11	4 4 4 4	72 36 44 44
Southern Punjab	Bhakkar (4) Muzaffargarh (3)	Darya Khan Jatoi	8 11	4 4	32 44

	Rajanpur (3) Multan (4)	Jampur Shujabad	13 11	4 4	52 44
Total		8	112	32	368

*Note: Values in parenthesis are total number of tehsils in selected districts

3.2. Model Specification

To probe the determinants of farmers awareness regarding climate change, the study will use the Binary logit model. The odds ratio is the best estimating technique to measure the maximum likelihood method that gives the reliable coefficient based on the classifying the observed data. The logistic model estimates the probability of success as compared with the probability of failure and these results are extracted from the odds ratio [P/1-p]. In our model, farmers' awareness is the dependent variable and in which farmers were asked about their awareness level by categorizing their awareness between zero and one.

$$Li = ln\left(\frac{pi}{1-pi}\right) = \beta i + \beta_2 X_i + u_i$$

Where βs are the vectors for binary regression and μi is representing error term depicting the zero mean and constant variance. Where X_is are the farm and farmers specific variables, socio-economic and demographic factors and institutional factors as well. Where $\frac{\rho i}{1-\rho i}$ is the logit of the farmers' awareness to climate change where ρi indicates that farmers are aware and 1- ρi depict that farmer are unaware of climatic variation. Moreover, X_is points out the 1×K vector of the factors which are affecting the farmers awareness and error term. Odd ratios of the model explain the occurring of the event or not and its maximum likelihood $\frac{\rho i}{1-\rho i}$. It keeps the other things remain the same and predicts the chance of occurrence of the event. The study incorporated the marginal effects to forecast the probability of awareness to climate change of the farmers occurred by unit change in the independent variable from the mean value. The equation for the marginal effects is given below.

$$\frac{\partial \rho j}{\partial x_k} = \rho_j \left(\beta_{jk} - \sum_{j=1}^{j-1} \rho_j \beta_{jk} \right)$$

Marginal effects measure one unit change in the independent variable cause change in the dependent variable holding other factors constant. The basic function the marginal effects is to observer and interpret the impact of predictors on the dependent variable.

Table 3: Description of the Variables

Variable	Mean	Std. Dev.	Min	Max
Awareness	0.6875	0.469977	0	1
Age	40.02174	13.50465	16	80
Education	8.342391	5.044991	0	18
Log (Experience)	2.609672	0.83573	0.693147	4.007333
Earning Members	2.600543	1.47299	1	8
Credit Facility	0.497283	0.500673	0	1
Extension Services	0.649457	0.47779	0	1
Own tubewell	0.695652	0.643376	0	1
Own tractor	0.646739	0.51695	0	1
Member Organization	0.524457	0.500081	0	1
Tenancy Status	0.75	0.433602	0	1

Table 3 presents the descriptive statistics of the variables, based on a sample of 368 observations. The primary variable of interest, awareness of climate change, indicates that 68.77% of respondents are aware of the issue, with a mean value of 0.6877 and a standard deviation of 0.46997. The age of respondents spans a broad range from 16 to 80 years. In terms of education, respondents have an average of 8.34 years of schooling. Farmers' experience is another important variable, with an average of 2.60 years and a standard deviation of 0.84. Additionally, the number of earning members per household averages 2.60, with a standard deviation of 1.47. The availability of a credit facility is also assessed as a critical factor in raising farmers' awareness with a mean of 0.497 and a standard deviation of 0.50. Similarly, extension services, another dichotomous variable, suggesting that approximately 65% of farmers have access to these services. The mean value for tubewell ownership is 0.69 with a standard deviation of 0.64, while tractor ownership has a mean of 0.64 and a standard deviation of 0.52. Another relevant variable is membership in farmer organizations, with a mean of 0.524. Finally, tenancy status, which categorizes farmers based on land ownership and leasing arrangements, has a mean value of 0.75 and a standard deviation of 0.43. presents a detailed overview of the variables analyzed in the study, based on a sample of 368 observations. The primary variable of interest, awareness of climate change, indicates that 68.77% of respondents are aware of the issue, with a mean value of 0.6877 and a standard deviation of 0.46997. This binary variable ranges from 0, indicating a lack of awareness, to 1, indicating awareness.

The age of respondents spans a broad range from 16 to 80 years, with an average age of 40.02 years and a standard deviation of 13.50. This range highlights a diverse representation of individuals within the labor force. In terms of education, respondents have an average of 8.34 years of schooling, reflecting varying educational backgrounds from no formal education (0 years) to higher education (18 years). The standard deviation for education is 5.044, emphasizing the significant variation in educational attainment across the sample.

Farmers' experience is another important variable, with an average of 2.60 years and a standard deviation of 0.84. Experience levels range from 0.69 years to a maximum of 4.01 years, indicating differing levels of farming expertise within the population. Additionally, the number of earning members per household averages 2.60, with a standard deviation of 1.47. This variable ranges from 0 to 8, reflecting the diverse household structures contributing to family income.

The availability of a credit facility is also assessed as a critical factor in raising farmers' awareness. This is measured as a dummy variable, with a mean of 0.497 and a standard deviation of 0.50, indicating that nearly half of the respondents have access to credit. Similarly, extension services, another dichotomous variable, show a mean of 0.649 with a standard deviation of 0.477, suggesting that approximately 65% of farmers have access to these services.

Assets, such as owning a tubewell or a tractor, also play a significant role. The mean value for tubewell ownership is 0.69 with a standard deviation of 0.64, while tractor ownership has a mean of 0.64 and a standard deviation of 0.52. Tractor ownership ranges from 0 to 2, indicating that some respondents may own more than one tractor. Another relevant variable is membership in farmer organizations, with a mean of 0.524 and a standard deviation of 0.50, showing that just over half of the respondents are affiliated with such organizations.

Finally, tenancy status, which categorizes farmers based on land ownership and leasing arrangements, has a mean value of 0.75 and a standard deviation of 0.43. The range for this variable is from 0 to 1, indicating the proportion of farmers who are either tenants or landowners. These variables collectively provide a comprehensive understanding of the demographic, economic, and social factors influencing farmers' awareness and participation in climate-related initiatives.

Figure 1

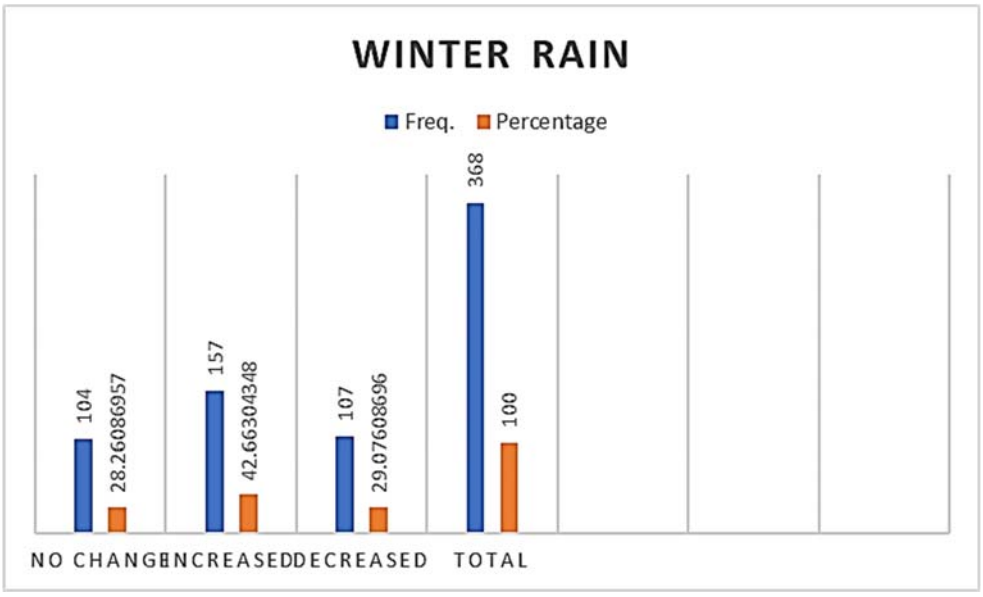

Figure 1 represents the data about the winter rain, 22.28 percent farmers responded that there is no change and 36.41 percent said that high decrease in winter rain. 18.20 percent responded that rainfall has decreased slightly and 11.68 percent informed that rainfall has increased slightly and 1.63 percent responded that number of rainy days has increased and 6.52 percent farmers responded that number of rainy days have decreased.

Figure 2

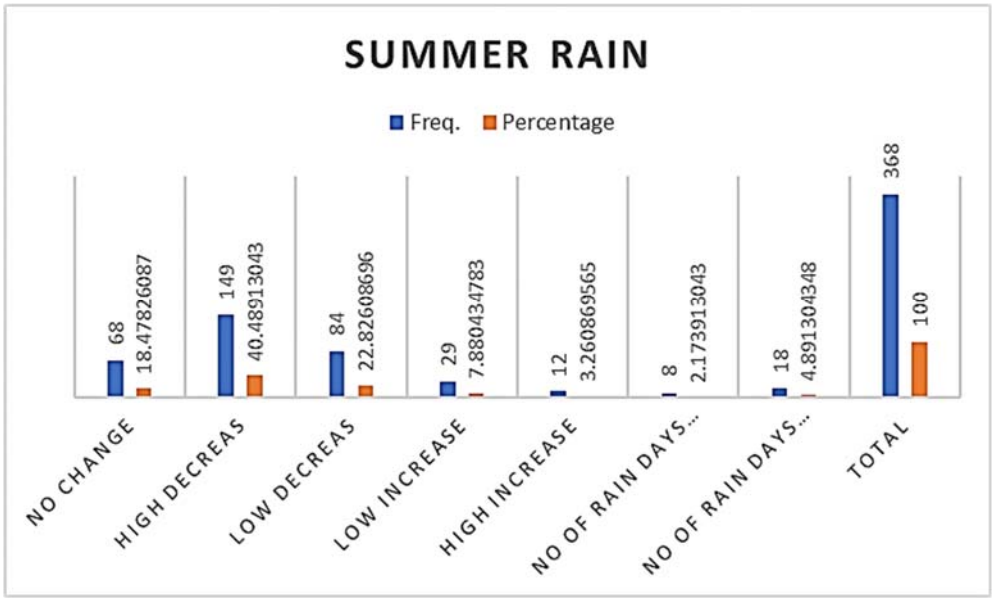

Figure 2 represents the data about the summer rain, 22.28 percent farmers responded that there is no change and 36.41 percent said that high decrease in winter rain. 18.20 percent responded that rainfall has decreased slightly and 11.68 percent informed that rainfall has increased slightly and 1.63 percent responded that number of rainy days has increased and 6.52 percent farmers responded that number of rainy days have decreased.

Table 4: Factors affecting awareness to climate change (dependent variable ACC)

Factors	Logit model	Odd ratios	Marginal Effects (dy/dx)
Age	0.0324** (0.0158)	1.032893** (0.016343)	.0065866 (.0032)
Education	0.0629** (0.0280)	1.064952** (0.029825)	.0128073 (.00567)
Log (Experience)	-0.752*** (0.257)	0.471658*** (0.121337)	-.152944 (.05166)
Earning Members	0.258*** (0.0996)	1.294705*** (0.12896)	.0525651 (.02007)
Credit facility	-0.496* (0.275)	0.608839* (0.167324)	-.1008144 (.05519)
Extension services	-0.370 (0.273)	0.691018 (0.188458)	-.0733223 (.05261)
Own tubewell	0.666*** (0.236)	0.513792*** (0.121467)	.1355303 (.0474)
Own tractor	1.260*** (0.303)	3.524031*** (1.067887)	.2563523 (.06018)
Member Organization	-0.533* (0.278)	0.586781* (0.163325)	-.1076098 (.05552)
Tenancy Status	0.801*** (0.285)	2.227539*** (0.634576)	.1747111 (.06495)
Constant	0.206 (0.611)	1.229135 (0.751458)	
Observations	368		

Note: Values in the parentheses are standard error, level of significance *** p<0.01, ** p<0.05, * p<0.1

4. Results and Discussions

Table 2 represents that age has significant and positive impacts of farmers awareness to climate change. For instance, odds ratio shows that higher age of the farmers 1.03 times more aware as compared to lower age of the. The results are in agreement with the Abid et al., 2016. Education is positively and significantly impacts of farmers awareness to climate change. For instance, odds ratio shows that educated farmers 1.14 times more aware as compared to uneducated farmers. The results are in agreement with the studies Mustafa et al., 2023. Similarly, log of experience has significant but negative impact on farmers' awareness to climate change. Experience plays very significant role in making perception and spreading awareness of climate change Usman et al., 2023. Where odd ratio shows that experienced farmers are 0.47 times more aware as compared to experienced farmers.

Similarly, earning members have significant and positive impact on farmers' awareness to climate change earning members play a very important role in making perception and spreading awareness of climate change. Where odd ratio shows that earning members of farmers is 1.29 times more aware as compared to experienced farmers.

Access to tubewell has a significant and positive impact on farmers' awareness to climate change Ndambiri et al., 2013. While the odd ratio was showing positive indication which states that 0.66 times more aware as compared to the farmers who do not have different own tubewell. Access to tractor is an institutional factor which is the determinant of farmers awareness and has a significant and positive impact on farmers' awareness to climate change Fahad et al., 2020. while the odd ratio was showing

positive indication which states that 1.26 times more aware as compared to the farmers who do not have different own tubewell.

Membership in farmers' organization has significant and positive impact on farmers' awareness as much as farmers are connected, they perceive in a better way in understanding climatic variation. Ado et al., 2019 suggested that farmer to farmer information and extension of farmers play a pivotal role in this regard. When farmers become member of some organization then they hold seminars and try to communicate and share information about the calamities of coming events. Here, this explanatory variable is significant and positive relationship with the farmers awareness. Where the odd ratio is 1.8433 explaining that 1.84 times farmers are aware of climate change as compared with those farmers who are not member of some famer organizations. Access to credit service is an important institutional factor and a major contributor in climate change awareness and has significant but negative impact on the farmers awareness. Where odd ratio postulates that 0.60 times farmers are aware of climate change who has access to credit services compared with the farmers who have no access to credit services. The tenancy status a major contributor in climate change awareness and has significant and positive impact on the farmers awareness. Where odd ratio postulates that 2.22. times farmers are aware of climate change who has to the tenancy status compared with the farmers who have no access to this status.

5. Conclusion

The study focused on the factors affecting farmers' awareness of climate change in the Punjab, Pakistan. It was envisaged that farmers are not aware of climate change and are not taking proper measures to adapt suitable techniques to mitigate the impact of climate change in Pakistan. Climatic variations have dented not only the economy of Pakistan but also the living style and well-being of the farmers. Therefore, determinants of farmers are imperative to enhance farmers awareness and adaptation methods are pre-requisite to ameliorate the financial condition. The study predicts the experience, education and family size are the farmers specific characteristics and playing positive and significant role in creating awareness of climate change in farmers' lives. Similarly, farm specific characteristics such as, distance from market, landholding, occupation and farm type are the variable which are stimulator in farmers awareness. Moreover, institutional factors such as, member of organizations, agricultural credit, bardana, extension services are very influential explanatory variables pertinent to awareness to climate change. The study also described the financial constraints to the farmers regarding climate change. However, farmer specific characteristics and farm specific characteristics are very important and significant to affect the farmers awareness. Such as, education, experience and family size have a positive and significant relationship with farmer awareness and logistic regression compared these results with those farmers who do not have access to these factors. Their economic losses were greater as compared to the farmers who have acquired education and experience and have large families. Moreover, occupation and member of organization has significant impact on the farmers awareness and access to extension services and facility of bardana has the same positive impact.

Precisely, the study found variety of managements strategies to enhance farmers awareness and to mitigate impact of climate change. There are some supporting factors which are paving the way to meet the objectives like education, experience and other farmer specific characteristics. On the other hand, some are obstructing factors which are creating hurdle in adapting different adaptation strategies to enhance farmers production like, financial constraints and lack of access to the market, credit facilities and ultimately dearth of farmers awareness to climate change. The current study found a positive and significant factors affecting farmers awareness to climate change and their adaptation strategies.

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