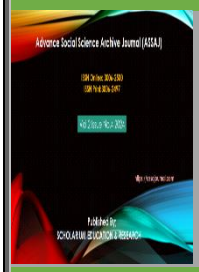

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DETERMINANTS OF FARMERS' ADAPTATION TO CLIMATE CHANGE IN SELECTED VILLAGES OF DISTRICT MARDAN

Hussain Khan	MPhil Graduate, Institute of Development Studies Faculty of Rural Social Sciences The University of Agriculture, Peshawar Khyber Pakhtunkhwa-Pakistan
	Email: e- psfaup@gmail.com
Yahya Khan	MPhil Graduate, Department of Environmental Economics, Pakistan Institute of Development Economics, Islamabad Pakistan
	Email: e- yahya.khan66@yahoo.com
Khuram Nawaz Sadozai	Associate Professor PhD, Department of Agricultural & Applied Economics, The University of Agriculture, Peshawar, Pakistan
	Email: e- ksaddozai@hotmail.com
Muhammad Aslam	UNICEF PITE, Education Department Baluchistan
	Email: e- makbabar3@gmail.com

ABSTRACT

This study was conducted to find out determinants of farmers' adaptation to climate change in selected villages of District Mardan. Three villages namely Hoti, Taus Banda and Mani Khel of Mardan were purposively selected for the study. The total sample size of 161 households was selected using Yamane formula. Primary data was collected through a pre-tested questionnaire. Data was analysed using SPSS. Descriptive statistics reveals that 48% respondents had acquired education up to secondary level. The results further show that 51% respondents cultivated land in the range of 6-10 Jirab (3-5 Acres). About 93% of the respondents were reported that they observed long term changes in term of climate variables. Similarly, 69% of the respondents reported that they have adapted to the climate change and use various adaptation strategies. These strategies included planting different crop varieties (reported by 69%), adjustment in sowing periods (reported by 78%), changes in irrigation timing (reported by 72%). using improved seeds (reported by 67%), use of chemical fertilizer and pesticides (reported by 70% and 68% respectively). Likewise, the estimates of binary regression analysis reveals that coefficient for household income, untimely rains and drought occurrence had positive and significant effects on adaptation to climate change. The overall model was highly significant as shown by the p-value less than 0.001. The study confirms that respondents in the target area have observed climate change and have made some adaptation to climate change. The study

1. INTRODUCTION

recommends initiatives such as awareness programs should be initiated at farm level to improve farmer's adaptation capacity and enhance the crop resilience to climate change.

Key Words: Adaptation, Binary Logit Model, Crop resilience, adaptation Capacity

Climate change is one of the major problems related to environment that the modern world is facing today. This can cause variations such as shift in rainfall pattern, rise in sea level, and shift in climatic regions due to escalation in temperature level. The level of floods, storms and prolonged shortage in the water supply occur due to shift in the climatic patterns. The hazards that are linked with weather as well as the extreme climatic changes can significantly be seen increasing due to turn around in the climatic volatility (Akcaoz et al., 2005; Ahmad et al., 2007). The natural calamities (such as storms, droughts, floods hail storms and cyclones) are unpredictable, therefore, it is noticed that the majority of rural farming population has absolutely no counter balance. The farmers should recommend following various techniques, for instance to modify their cropping patterns and agricultural operations and adjust their water supplies to deal with the unpredictability of the climate change and weather (Birks et al., 2015).

Moreover, due to climatic changes change in terms of flood and drought results in dwindling productivity of major crops across the globe. According to the reports of Bureau of Statistics, poor people are highly vulnerable to natural calamities due to their less bounce back capacity (Rosenzweig and Hillel, 2008). Similarly, agriculture sector in Pakistan is reported to be highly exposed to climate change due to which the scientists, policy makers and development experts pay attention to the existing policies and trying to modify it in the light of climate compatible development strategies. Agriculture is the lynchpin of Pakistan's economy but there are certain features of climate change which compromises farming competence in rural areas both physically and financially. There are certain list of factors that includes accessibility to water, variation in the pattern of rainfall, significant rise in the temperature, changes in the periods of harvesting and sowing and appropriate land suitability (Sultana and Ali, 2006).

Farmers, the real stakeholders can face the challenges of adaptation at the local level. Because of steady local markets farmers' may get benefit in return of payment due to the high cost of production and high market prices. But if we overlook at the developing nation such as Pakistan we are unable to see such setup in Pakistan, farmers' usually receives low returns from their productivity due to the high cost of production because the prices are controlled by the non-market forces (Niles et al., 2015). However, the promote resistance to climate change, the adaptation practices can be in various forms such as independent and deliberate. Hence there are numerous adaptations measures that are available. In water resource sector, methods such as

rainwater collecting is considered one of the essential method used for adaptation practice (Gedefaw et al., 2018).

For the effective outcomes, the adaptation strategies needs to be implemented at various levels such as local and national and for review the implementation circumstance needs to be evaluated at several exposed areas (Enete and Amusa, 2010). However, adaptation is must in agriculture sector to improve the resilience of farmers in developing countries who are highly vulnerable to the environmental catastrophes. Likely, Pakistan where the minor loss in the agricultural productivity results directly in huge loss of income because it is reported that agriculture holds a great part of Gross domestic product (GDP). Whereas, the decline in the productivity of agriculture causes poverty and looming crisis of food security (Ali and Erenstein, 2017). There are some household features that play vital role in adaptation to climate change such as age of farmer, in which the farmer who are elder in age are considered to have a lot of knowledge about farming operations and climate change based on observation, and are likely to recognise the importance of adaptation to farmers' livelihoods (Deressa et al., 2009). In Pakistan, majority of the farming communities are mostly vulnerable to climatic changes and relies upon adaptation practices in filed. Although, the adaptation practices are significantly important, but to lack of information farmers are unable to use these ideas and practices for adaptation to climate change (Baig and Amjad, 2014; Ahmad et al., 2013).

Pakistan, being a developing country is reported to be in desperate need of adaptation techniques. However, reliable information can increase farmers adaptive. Besides, there are certain adaptation strategies such as modification in financial and agronomic practices would enhance the farmer's capacity to overcome the negative impacts of climate change. (Nhemachena and Hassan, 2007).

Over last few years Pakistan has been under the target of climate change, whereas the adaptation for these effects laid to be compulsory for the advancement of social and economic development. Under such prevailing scenario Ministry of Climate Change has adopt numerous steps to correspond the population and uplift the awareness with the national climate policy concerned adaptation and mitigation creativity. There are various areas such as agriculture, town planning, forestry, livestock, transport, energy and industrial sectors which needs to be focused to mitigate the impacts of climate (Vickers, 2017). Thus, the present study was aimed to probe out problems encountered by farmers in rural areas of District Mardan. In order to understand the main problem faced by these farmer's, literature shows that climatic changes has arisen multiple issues at the field level. Similarly, the farming community residing in the rural areas of Pakistan have no alternative to overcome the improve the crop resilience to climate change. Pakistan's annual average temperature has increased by roughly 0.5 C^{o} in the

last 50 years. However, the changes in rainfall pattern have become serious threat to the farming community in order to cope with the climate change. Poor farmers' are likely to be more exposed to the impacts of climate change due to low incomes, limited capacity to seek alternative livelihoods and has resulted in declining agriculture productivity. In Pakistan, different farmers try numerous strategies to adapt to climatic challenges. However District Mardan is surrounded by various gravity canals to fulfil the agriculture activity, as water harvesting is mainly carried out in the fields but due to the various climatic change occurring in recent years have made farmers unable to handle with shocks that are induced by the climate change. To probe into the problem, this study has been planneed to identify various adaptation strategies that farmers in research area adopt in response to climate change. Secondly, to investigate the determinants of farmers' adaptation to climate change. Lastly, to give policy recommendations based on the study findings.

II. LITERATURE REVIEW

Salick et al., (2007) studied that the climate change develops poverty and challenges related to the poverty strategies due to which deprived ones will be suffering the most from it. Similarly, Hassan et al., (2008) used a multinomial choice model to investigate the causes of farm level adaptation strategies in Africa. According to the findings of the study, it is found that specialised crop production such as mono cropping is the agricultural technique that is considered to be exposed most to climate change that occurs in Africa. However, access to the credit services, recent innovations, markets, extension services and agricultural assets including (capital, land, labour) enhance farmers adaptive capacity to climatic changes. Banerjee et al., (2013) led a study in small town of Spiti and find that despite farming community was informed about the climate related hazards and they are practicing adaptation strategies, still they require awareness such as access to technological advancement for enhancement of their adaptive capacities for productive adaptation strategies. Esham et al., (2013) examined the adaptation to climate change in Sri Lanka and found that farmers are aware about the extreme events of climate Change, however, the management of the non-climatic concerns were considered to be the crucial factors for the enhancement of farmers' adaptations. Likely, Le Dang et al., (2014) examined the intentions of the farmers' practising adaptation by applying structural equation model. The results obtained from the model reveals that farmers' intention for adaptation rises when they ascertain about higher risks related with climate change and high efficiency of adaptive actions. The outcome of this study discloses that for understanding the behaviour of farmers and their intention related to climate change protection motivation theory is appropriate. Ndamani et al., (2016) conducted a study in Lawra District of Ghana using weight average index and logistic regression model and found that logistic regression

indicated the most important factors that have influence on the farmers' adaptation to climate change including access to affiliation of farm based organization, credit and information, annual household income, size of household and education level. Li et al., (2017) conducted a widespread survey that was based on the households to examine the existence of of adaptation strategies in the specific countries i.e. Hugary, Tolna and Veszprem. Findings confirmed that response and adaptation to to climate change was getting stronger by the enlarged response of the marked climate change occurrences that consists as follows, happening of extreme weather events and water shortage and through decision making of farmers. Salman et al., (2018) discovered the views of farmers' about the existing adaptation measures for climate change that is considered key to success for the adaptation strategies. Majority of the farmers declined that climate change being potential threat to agriculture, so they don't rely on any amendments being done in the farming practices. However, there were certain adaptation methods such as drip irrigation, plantation of trees and using of different varieties of crops in the study area. Akhtar et al., (2020) probed the foremost determinants for farmers while adopting the various adaptation strategies in Malaysia. Findings revealed that education level and income level had positive effect on farmers adaptation strategies and also confirmed that farmers' were familiar about the effects that are caused by the climate change include increase in rural-urban migration, rise in food expenses and land degradation. Jan et al., (2021) examined the climate change effects on the productivity of cereal crops that includes (maize and wheat) using the autoregressive distributed lag (ARDL) model. Findings show that in the long run, the impact of average minimum temperature on both crops is found negligible. The short-run influence of average minimum temperature on maize crop output is considerable, but not on the wheat crop yield. Hence, the study suggest that extending the land under cultivation, developing efficient irrigation systems, and access to metrological data would indeed aid to mitigate the negative effects of climate change on agriculture production

Data, Model and Methodology

This part deals with the methods which will be used for the study to collect and analyze the data. It describe universe of the study, sample respondents, data collection methods and data analysis.

3.1 Universe of the study

District Mardan constitutes the universe of this study. Mardan which is the second largest district comprises of five tehsils i.e. Takhtbhai, Mardan, Katlang, Rustam, and Garhi Kapoora. The total population covers 2,373,061 out of which the total members of household is 311,868 (Government of Pakistan, 2017).

3.2 Sampling procedure

Sample size and its selection was based on lands that are more irrigated, less irrigated and non-irrigated from three villages namely Taus Banda, Mani Khel and Hoti. The total number of households' in Taus Banda is 125, the total population of households in Mani Khel is 30 and the total population of households in Hoti is 115 (Government of Pakistan, 2017). Thus the total number of households in the three villages is 270. The following Yamane formula was used to select sample size from the total population.

$$n = \frac{N}{1+N(e)^2} \quad \text{.....3.1}$$

Where,

n = Total sample households (Sample size)

e = Precision level which is set (0.05)

N = Number of total households

By putting values, the required sample size was determined as

By putting the values in equation 3.1, the required sample size was determined

$$n = \frac{270}{1+270(0.05)^2} = 161$$

In the next step, proportionate sampling techniques was used to select the required sample.

$$n_i = \frac{N_i}{N} * n \quad \text{.....3.2}$$

Where,

N_i = Total number of households in each village

i = Number of villages in the study area (i=1, 2, 3)

n_i = required number sample households in each village

n = Total sample size

N = Total number of households in the study area

Using formula 3.2, the following sample size was determined for each village.

n_1 = 125/270×161 = 75 (Taus Banda)

n_2 = 30/270×161 = 18 (Mani Khel)

n_2 = 115/270×161 = 68 (Hoti)

The total number of households in each village and the respective sample size is given in Table 3.1.

Table 3.1 Sample selection procedure

Villages	Total number of households	Total sample size
Taus Banda	125	75
Mani Khel	30	18
Hoti	115	68

Total	270	161

3.4 Data collection technique

The data was collected from three villages in District Mardan. A semi structured questionnaire was designed to collect the data from the three selected villages; namely Taus Banda, Mani Khel and Hoti. The questionnaire consisted of information about agriculture practice, determinants of farmers on climate change, farmer's adaptation options, and barriers to adaptation strategies. The questionnaire was pre-tested in the field to include necessary information, or omit unnecessary information from the questionnaire.

3.5 Variables used in the study

The dependent variables of the study is whether respondents use any adaptation strategy or not. Various adaptation strategies were selected after studying literature and exploratory study of the research area. The details of the dependent variables, independent variables and expected signs of variables are given in Table 3.2.

Table 3.2 Description and expected signs of variables used in the model

Variable	Measurement	Expected sign
Dependent Variables **Use of adaptation strategy.** **(Improved seeds, use of chemical fertilizers, use of pesticides, planting of different crop varieties, adjustment of sowing periods, changes in irrigation time, others)**	If using any adaptation strategies =1 or 0 if otherwise.	
Independent Variables		
Annual income of households	Quantitative (PKR)	+
Farm land size owned	Quantitative (In Jirab)	+
Farming experience	Quantitative (Years)	±
Access to credit	1= if yes, 0= otherwise	+
Access to extension services	1= if yes, 0= otherwise	+
Untimely rains	1= if yes, 0= otherwise	+
Drought occurrence	1= if yes, 0= otherwise	+

3.6 Data analysis

After the data collection from the study area, to analyze the collected information. It was modify from questionnaire to computer. The analysis was done by statistical package for social sciences (SPSS) through frequencies, percentages and binary logit model.

3.7 Binary logit model

Binary logit model was used in order to analyze various factors influencing the farmers' decision in implementing adaptation measures to extreme weather events. The general equation of a binary logit model is viewed as follows:

$$\log\left(\frac{P}{1-p}\right) = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4D_1+\beta_5D_{2+}\beta_6D_{3+}\beta_7D_4 \text{ .....3.3}$$

Whereas;

P= Probability of Y=1, 1-P = Probability of Y =0

Y= Use of adaptation strategies (1 using at least one strategies, 0=No)

X_1= Annual household income (PKR)

X_2= Farm land size owned (Jirab)

X_3 = Farming experience (years)

D_1 = Indicate access to credit (1= yes, 0= no)

D_2 = Access to extension services (1= yes, 0= no)

D_3= Untimely rains (1= yes, 0= no)

D_4 = Occurrence of drought (1= yes, 0= no, respectively.

β_0= Constant

βs= Coefficient of the variables

IV. RESULTS AND DISCUSSION

4.1 General characteristics of the sample respondents

This section consists of general characteristics of the sample respondents. Literacy status, number of household members, number of working household members along with other characteristics are discussed in detailed as below.

4.1.1 Literacy status of the sample respondents

Education plays a vital role that helps to compete with anything due to extensive depth of knowledge. It is considered to be an important factor at farming level because it enables the farmers' to have access to information about the ongoing changes occurring in the environment likewise it encourages them to adopt with the technological advancement taking place in the farming practices. Education level was considered to be highly effective to enquire information of advanced technologies for the farmers that belong to Virginia according to (Wuyan et al., 2008). It has been clear from the literature that education leads to positive adaptation (Deressa et al., 2011). Higher the literacy rate and experience in farming greater the individual household will adopt with the ongoing changes occurring in the climate (Elahi et al., 2015 and Abit et al., 2015). The results shown in the table indicates the different education level of the sample respondent, which are categorized in different level such as illiterate, primary, secondary, high secondary and graduation and above.

Table 4.1 Distribution of sample respondents on the basis of literacy status

Education level	Frequency	Percentage
Illiterate	16	10
Primary	12	8
Secondary	78	48
High Secondary	50	31
Graduation and above	5	3
Total	161	100

Source: Field Survey, 2021

Table 4.1 shows that education level of the farmers' belonging to the study area. Whereas, it is not necessary that all the farmers' would have same level of education thus, for better understanding the level of education is categorized as illiterate (having no education), primary, secondary (matric), higher secondary (FA/ FSc), graduation (16 years or above). According to the field survey the results obtained portrays that 10% of the respondents were illiterate having no qualification, while 8% of the respondents were recorded having primary qualification and whereas it has been recorded that majority of the respondents were having secondary qualification that was highest among the rest of level of education. Followed by high secondary level of education that was about 31% while only 3% of the respondents had graduation qualification that was the least among the rest. Thus the results contrary with the findings of (De Jonge, 2010) who found that farmers acquiring university qualification seems to respond to climate change than those who have primary level of education because of the financial resources that made them reserved to farming practices. Thus, the results of the table are in line with (Shen et al., 2015). The literacy status of rural areas of Khyber Pakhtunkhwa is considered to be low as compared with the rest of provinces but slightly higher than Balochistan (Anon, 2012).

4.1.2 Number of household members

From previous numerous studies it is assumed that number of household size holds greater importance in line with climate change adaptation because higher the number of household size less will be dependency on outside labour. Findings from the studies of (Croppenstedt et al., 2003 and Deressa et al. (2009) derived a positive relationship between household size and adaptation to climate change. The results in below table thus indicates the number of household member's which are categorized in different numbers.

Table 4.2 Distribution of sample respondents on basis of number of household members

Number of household members	Frequency	Percentage
1-6	44	27
7-9	74	46
10-12	34	21
13-15	9	6
Total	161	100

Source: Field Survey, 2021

Table 4.2 shows about 27% of respondents were reported to belong among 1-6 household size, whilst the majority of the respondents about 46% consisted 7-9 family size and about 21% of the respondents were reported to have 21 household size. While the least of household size were 6% that belonged to the family size of 13-15. Previous studies reveals that the farmers having large number of families are considered to be adopting more adaptation practices. While larger families' size enables the farmers to engage small proportion that are involved in farming practices into off farm activities for generating income and minimize the demand of consumption (Tizale, 2007).

4.1.3 Number of working household members

Working household members carries important role in sustaining income and livelihood in the abrupt climate changes. Large working members strive hard to enhance their productivities through improved farming innovations while those who have less working house hold members usually depends upon non-farm employment to survive. The results below in the table shows the responses collected from the respondents in the study area.

Table 4.3 Distribution of sample respondents on basis of working household members

Number of working members	**Frequency**	**Percentage**
1-3	113	70
4-7	47	29
7-10	1	1
Total	161	100

Source: Field Survey, 2021

Table 4.3 shows the different responses that were collected from the respondents regarding total working household members. They were further categorized into different numbers i.e. 1-3, 4-7 and 7-10. It is concluded from the findings that majority of the working house hold members' holds 70% which is the considered to be the highest among the rest of working house hold members, whilst it is revealed that only 29% of the respondents were those that consisted of 4-7 working household members. While 7-10 working household member holds just about 1% that was least among the rest of the responses.

4.1.4. Total land cultivated

Land area indicates the total land area that is in the hold of the farmer house hold thus it is considered to be an alternative source of household wealth. From previous numerous studies conducted accomplishes that larger the land size more it enables the farmers to adopt with newly invent farming practices without lack of piece of land for carrying out agricultural activities. It is concluded from the study of (Mudzonga, 2012) that greater farm size, it is more likely that greater the share of land assigned for modern varieties of crops and the adaptation strategies that farmer is more expected to adopt. Large scale farmers usually face less limitations to adopt climate change.

Table 4.4 Distribution of land size holding of the sampled respondents in the study area

Total land cultivated in Jirab	Frequency	Percentage
1-5	76	47
6-10	82	51
11 and above	3	2
Total	161	100

Source: Field Survey, 2021 * 1 Jirab= 0.2 Hectare, 1Hecatre= 2.4 Jirab

Table 4.4 below is classified into three various land cultivated groups. These groups are categorised into different numbers ranging from 1-5 Jirab land, 6-10 and 11 and above. The results reveals that the total land cultivated in the range of 1-5 Jirab was 47% whereas the majority of the land cultivated was around 6-10 Jirab that is 51%, whereas only 2% of the total land cultivated was reported to be 11 and above Jirab. Thus these findings are considered to be in line with the findings of (Mikulincer et al., 2003).

4.1.5 Long term changes in climatic variables

The response from the targeted respondents were different regarding the long term changes in the term of climate variables. The responses from the targeted three villages revealed that majority of the respondents had observed long term changes in term of climate variables that accounts about 93%, whereas few respondents that holds about 7% were those respondents that had not observed any long term changes in the climate.

Table 4.5 Distribution of sample respondents on the basis of observing long term changes in the term of climate variables.

Response	Frequency	Percentage
No	11	7
Yes	150	93
Total	161	100

Source: Field Survey, 2021

Table 4.5 explains the responses of the targeted respondents that indicates the observing long term changes in the term of climate variables. The findings reveals that 11 respondents that accounts about 7% reported that they have not observed any long term changes in the term of climate variables, whereas majority of the respondents that holds up to 93% revealed that they have observed long term changes in the term of climate variables. Thus it portrays that majority of the respondents in the targeted villages has observed long term changes in the term of climate variables which concludes that occurrence of the climate change has been observed by the residing population.

4.1.6 Adaptation to climate change

Have you adopted to climate change is dependent variable of the research study hence various response from the farmers' of three villages at field were obtained out of 161 respondents, 31% were those respondents that had not adopted to climate change whereas 69% respondents were those respondents that had adopted to climate change.

Table 4.6 Distribution of respondents on the basis of adaptation to the climate change

Response	Frequency	Percentage
No	50	31
Yes	111	69
Total	161	100

Source: Field Survey, 2021

Table 4.6 expresses the responses of the respondents regarding adaptation to the climate change. 31% of the respondents were reported that they have not adapted to the climate change, whereas majority of the respondents reported to have adaptation to the climate change in the targeted area that was almost 69% which indicates that majority of the respondents had been in contact with adaptation to the climate change.

4.1.7 Planting of different crop varieties

The response of the farmers related to adopting to climate change included planting of different crop varieties. According to the data collected from 161 total sample respondents' 69% respondents were those respondents that stated no to planting of different crop varieties, whereas 31% of the respondents were those that were in contact with planting of different crop varieties.

Table 4.7 Distribution of sample respondents on basis of planting of different crop varieties

Response	Frequency	Percentage
No	111	69
Yes	50	31
Total	161	100

Source: Field Survey, 2021

Table 4.7 shows the responses of the respondents regarding the use of various adaptation strategies starting from planting of different crop varieties. The above findings indicates that 69% out of the total respondents were those who did not opt for planting of different crop varieties, whilst 31% of the respondents were those that were reported to be planting different crop varieties in order to tackle with rapid change in the climate and opt accordingly with their income.

4.1.8 Adjustment of sowing periods

To cope with adverse effects of advanced climate change farmers usually carry out various adaptation strategies to minimize the opposing effects of climate change. In this present study the respondents had various response for adjustment of sowing periods. Majority of the respondents that accounts about 78% that reported for not practising the adjustment of sowing periods whilst 22% were those respondents that practiced adjustment of sowing periods as adaptation strategies to cope with climate change.

Table 4.8 Distribution of the respondents on basis of adjustment of sowing periods

Response	Frequency	Percentage
No	126	78
Yes	35	22
Total	161	100

Source: Field Survey, 2021

Table 4.8 portrays about adaptation strategies being used in the targeted area. The findings reveals that majority of the respondents about 78% reported that to adapt with climate change they did not opt for adjustment of sowing periods. Whilst 22% out of the total respondents revealed that they are being in contact with adjustment of sowing periods in the targeted area to act accordingly with the advance climate change.

4.1.9 Changes in irrigation time

The response from the farmers' about adjustment in the irrigation time revealed that out of the total respondents 72% of the respondents were reported to be those farmers that did not practiced changes in irrigation time as an adaptation strategies to cope the adverse effects of climate change whilst 28% respondents were reported to be those farmers that adopted with climate change by implanting changes in their irrigation time.

Table 4.9 Distribution of sampled respondents on the basis of changes in irrigation time in the study area

Response	Frequency	Percentage
No	116	72
Yes	45	28
Total	161	100

Source: Field Survey, 2021

Table 4.9 shows the responses of the respondents regarding alter in irrigation time. Out of total sampled respondents 72% of the respondents were those that were reported having no changes in irrigation in the study area. Whilst 28% of the respondents were those that revealed about changes in irrigation time in the study area in response with climate change.

4.1.10 Using improved seeds

From the previous literature it's been reported that majority of the farmers endorse improved seeds to tackle with the climate change and by minimising the risks that are interlinked along with it. But due to low earnings of the farmers and high input costs of agriculture farmers that are poor usually rely on low quality seeds. In this study it is reported that 33% of farmers did not used improved seeds this is due to low earning farmers. Whilst 67% of the farmers were reported that used improved seeds to enhance their adaptation to climate change and protect their farm lands.

Table 4.10 Distribution of respondents on basis of using improved seeds

Response	Frequency	Percentage
No	53	33
Yes	108	67
Total	161	100

Source: Field Survey, 2021

4.1.11 Using chemical fertilizer

Majority of the modern world farmers rely on practise of chemical fertilizer to sustain their yield, whereas when it comes about climate change so there are certain views of the farmers by practising the usage of chemical fertilizer. From the study area it's reported that about 30% of the respondents out of 161 respondents were those that did not used chemical fertilizer in their farm lands, whereas on the other hand majority of the farmers about 70% were those farmers that were in contact with use of chemical fertilizer.

Table 4.11 Distribution of sampled respondents on the basis of chemical fertilizer in the study area

Response	Frequency	Percentage
No	49	30
Yes	112	70
Total	161	100

Source: Field Survey, 2021

The response reveals that among the three targeted villages the response of respondents about using chemical fertilizer was found about to be 70%. Whilst about 30% of the respondents indicated that they did not practised using chemical fertilizer. These findings are align with study conducted by (Ndamani et al., 2016) at Ghana district which portrayed that respondents were likely to adopt with advance climate change by implementing using of chemical fertilizer.

4.1.12 Pesticides use

Considering the adaptation strategies to restrict the opposing effects of the climate change usually farmers use pesticides as an adaptation strategies. Whilst, in the study area it is revealed that among the total respondents 32% were those farmers that did not use pesticides, whereas 68% were those farmers that endorse the use of pesticides in response to the climate change as an adaptation strategy.

Table 4.12 Frequency distribution of respondents on basis of pesticides use

Response	Frequency	Percentage
No	51	32
Yes	110	68
Total	161	100

Source: Field Survey, 2021

According to findings it's revealed that out of 161 total respondents from three villages 32% were those respondents that declined the pesticide use while performing agriculture practices. Whereas, 68% of the respondents were reported to be those respondents that were practicing the pesticide use to adopt with advance climate change. Thus, these outcomes are supported by findings of (Suvedi et al., 2017).

4.2 Binary logistic regression

Binary logistic regression model was used in this study to perform the analysis of the independent variables. The total observations were 161 thus it showed that household income, untimely rains and occurrence of drought had significant effects on adaptation to climate change with a positive sign. Whereas the farm land size owned, farming experience, access to credit had a negative sign after analysis. Farm land size owned, farming experience did not reveal any significant effect on adaptation to climate change that could be due to farmers' that had small landholding thus these findings are similar with (Jan, 2012).

4.2.1 Descriptive statistics of variables

The descriptive statistics of the variables that are used in the binary logit model are discussed as below in the table 4.13.

Table 4.13 Descriptive statistics of the variables used in the binary logit model

Variable description	Mean/Proportion	Std. Dev	Min	Max
Dependent variable Use of adaptation strategy (1=If using, 0= if otherwise)	.69			
Independent Variables Annual income of households	475021.12	244546.936	36000	1104000
Farm land size owned	5.91	2.511	2	3
Access to credit	.17			
Access to extension services	.20			
Untimely rains	.63			
Drought occurrence	.35			

Table 4.14 Results of binary logistic regression

Independent variables	**β**	**S.E.**	**Wald**	**Sig.**	**Exp (B)**
Household income	.000	.000	8.092	.004	1.00
Farm land size owned	-.003	.106	.001	.979	.997
Farming experience	-0.22	.385	.003	.955	.979
Access to credit	-.369	.633	.341	.559	.691
Access to extension services	.699	.567	1.523	2.17	2.012
Untimely rains	1.519	.503	9.130	.003	4.567
Drought occurrence	1.617	.592	7.463	.006	5.039
Constant	-2.810	1.451	3.750	.053	.060
Number of observations= 161 Log likelihood= 167.819 Model Chi^2 (7)= 31.675 Prob. > chi2= 0.000					

In the study area the household income was found positive and statistically highly significant at .000. The results was alike to Gbetibuou (2009) who revealed that

farmers who have high income level are more likely to adopt with the climate change than the poor farmers. Whereas, Nhechema and Hassan, (2007) stated that the increase in per capita income cause positive influence on the farmers decision in concern with adaptation.

The estimated coefficient of total landholding was found with a negative sign -.003 and insignificant. This result are in line with the findings of Abid et al., (2015) that found out a negative relationship. From numerous research it's revealed that one third of farmers' in Pakistan have no land ownership Government of Pakistan, (2014–2015). Thus due to no ownership of land they pay huge land rents due to which they have no concern in major investments.

Farming experience was insignificant with a positive sign. The results can be compared with the outcomes of Okonya et al., (2013) who specified out an opposite relationship between farming experience and observing climate change. Whereas, the results are in contrast with the findings of Maddison, (2007) who stated that farmers having greater experience are more likely to observe the on-going climate situations. This scenario is because that highly experienced farmers' are reported to be less likely to adopt with advance climate change because they follow old tradition way of farming whilst the new emerging farmers' involve them self in learning about the advance adaptation to diminish the adverse effect of climate change.

The results obtained shows that access to agriculture in the study area was insignificant with a negative sign. Thus, these results are supported by the findings of Mudombi et al., (2014) who obtained similar results. These situation arises due to high interest rates that are charged by the institutions that provide loans to the farmers. Market access is considered to be the important factor that plays a vital role in affecting to adopt with agriculture advancement Feder et al., (1985). It is concluded from previous studies that the farmers' access to agriculture credit are usually consumed to fulfil their basic needs rather increasing their production.

In the study area access to extension services was found statistically insignificant. These results are in line with the findings of Kibue et al., (2015) who specified that access to extension services enables the farmers to adopt with the climate change. Access to extension services supports the farmers with up to date information regarding climate change and agricultural technologies. To shape the behaviour of farmers for adaptation to climate change access to extension services plays a vital role in it.

Untimely rains in the study area was found positive and statistically significant which defines that one unit increase in untimely rains corresponds to a 1.519 times increase in the long odds of the level of adaptation. These results are supported by the findings of Deressa et al., 2009 and Abid et al., (2016) who found positive sign for

untimely rains. According to Salman, (2011) he revealed that alter in the natural precipitation either in the form of snow or rain are considered as indicator for the change in climate.

Occurrence of drought was also found positive and statistically significant which defines that one unit increase in occurrence of drought corresponds to a 1.617 times increase in log odds of the level of adaptation. These results are in line with the outcomes of Spence et al., (2011) who revealed that occurrence of drought has a positive influence on the farmers from the last 10 years in Zimbabwe and thus have positive approach towards the adaptation to climate change. According to the researcher those farmers' who experience environmental risk they are consider to be more willing and cognitive to undergo environmental interventions.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Agriculture is one the vital sector that holds an important role in enhancing the economy of Pakistan. But due to the advanced climate change from past few years have made it difficult for the farmers to sustain their farming practices which is a global concern that the modern world is facing now a days. Although, being an important sector of Pakistan it has been ignored and tends to be neglected sector of Pakistan. It makes difficult for the developing nation to cope with the climate change due to their low earnings and geographic location due to which they are mostly exposed to the climate change as compared with the developed nation they have advance farming practices and up to date knowledge regarding the adaptation strategies carried out by the farmers due to high level of incomes. In Pakistan, majority of the farmers rely on agriculture products outcome to fulfil their basic needs of life but due to alter in rainfall patterns and not strong strategies to face these severe problems their demand is not yet being fulfilled and thus cause loss in their productivity. If proper adaptation strategies and make themselves use to advance farming practices this could boost their adaptation level to tackle it.

This study was carried to probe determinants of farmers' adaptation to climate change in selected villages of district Mardan amid three villages i.e. Hoti, Taus Banda and Mani Khel. In a total of 161 households 68 were taken from Hoti, 75 households were selected from Taus Banda whilst 18 were from Mani Khel. Primary data was collected by semi structured questionnaire, furthermore after the collection of data the analysis was done by using statistical package for social sciences (SPSS) through frequencies, percentages, and Binary logit model.

The literacy status wise distribution shows that 48% of the households with secondary level of education while only 3% reached to graduation and above level. While the family size shows that 46% lies in the range of 7-9 family members while

only 6% lies in the range of 13-15 family members. Larger the family size more the members could engage themselves into off farm activities from farming activities to generate more income and fulfil the demand. The findings also reveals that working household wise 70% lies in the range of 1-3 working members whereas only 1% were among the range of 7-10 working members.

The findings also shows that total land cultivated by the farmers reported to be 47% lies in the range of 1-5 Jirab, whereas 51% indicated 6-10 Jirab and only 2% portrayed 11 and above Jirab. Whilst the findings reveals that 7% of respondents did not observed any long term changes in term of climate variables whereas majority of the respondents that accounts up to 93% had observed long term changes in term of climate variables. Furthermore, the findings depict that majority of the respondents i.e. 69% of the respondents adopted to climate change whereas 31% respondents were reported that they did not adopted with climate change.

Furthermore, it is reported that various adaptation strategies were brought in use to tackle with on-going climate change that occurs with rapid change. Starting from planting of different crop varieties majority of the respondents i.e. 69% did not planted different crop varieties whereas only 31% of them planted different crop varieties. Whilst adjustment of the sowing periods shows that majority of the respondents that holds up to 78% did not adjust their sowing periods whereas only 22% were those that adjusted their sowing periods.

The findings also reveals that 72% of the respondents altered in their irrigation time while only 28% were subjected to have change in the irrigation times. Using of improved seeds were brought into practice by 67% while 33% did not practised the using of improved seeds. Majority of farmers in the field area were reported to be using chemical fertilizer while only 30% of them did not brought in use of chemical fertilizer. The usage of chemical pesticides portrayed that 68% of the sample respondents practised the use of chemical pesticides while only 32% denied the use of pesticides.

5.2 Conclusions

The study mainly aimed at determinants of the farmers' adaptation to climate change in selected villages of district Mardan. The study concluded that most of farmers had observed climate change. Thus, strong background and efficient measures are required to tackle the on-going climate change. Farmers rely on adaptation strategies to handle the drastic effects of climate change, but due to high costs of agriculture inputs most of farmers are unable to adopt. Market prices are controlled by stakeholders unfortunate farmers get low returns from their total production so they are unable to cope with climate change. Majority of the farmers were unaware about the extension services, and there demand were not yet fulfilled by the

Government, which makes them unable to understand about the issue. The study also revealed that household income, untimely rains and drought occurrence significantly influence the adaptation to climate change.

5.3 Recommendations

The conclusion of the study portrays that farmers' due to high input cost of agriculture outputs restrict them by using low quality seeds, whilst access to agriculture credit and agriculture extension services were not endorsed by the sample respondents. Thus keeping in view the overall findings following policy recommendations are suggested.

1. This study recommends that programs should be initiated at farm level to make awareness among farmers to encourage them to adapt. Sweeping efforts are needed to provide farmers with the most up-to-date information on climate change and potential adaption techniques throughout the world.
2. Moreover, there should be provision and proper monitoring of credit facilities to small farmers as it's considered major constraint in the way of adaptation strategies this would make easy for the farmers who are in need of credit for their farming practices.
3. Adequate attention and priority should be given by the government to policy measures directed towards agriculture sector to provide free agriculture inputs, loans on low interest rate, survey should be conducted at every villages to enquire about the issues that are faced by the farmers and best possible solutions to overcome the issues.

If these measures are strictly implemented by the Government it will not only resolve the damages that occurs due to the climate change but it will also enables the farmers to enhance and improve their socio economic conditions of farmers.

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