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Assessing Climate Change Impacts on Rural Livelihoods: A Case Study of Adaptive Strategies among Farm Families in Muzaffargarh, Punjab

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ABSTRACT

Climate change, being a global phenomenon, significantly impacts all living beings. The agriculture sector in Pakistan is more vulnerable to climate change due to its dependence on the climate and the fact that most Pakistanis directly or indirectly derive their livelihood from this sector. Agricultural production has shown a decreasing trend over the past years, constantly due to variations in the atmospheric conditions, which in turn comprise the farmer's livelihood, such as income, education, infrastructure and health. The prime objective of this study was to determine the impact of climate change on the rural farm families of Pakistan, mainly focusing on their livelihood. The nature of the study was quantitative. Data was collected by using multistage sampling. The total sample for the study was 200 respondents (50 respondents from each village). The pre-tested interview schedule was used to collect data, and a Chi-square test was applied. According to the outcomes, most farmers belonged to two age groups, 26-35 with 26.5 percent and 36-45 with 25.5 percent. The majority, 24.5% of the respondents, were matric qualified. The primary source of income for 62.0% of the respondents was farm activities. 98.5% of the respondents had heard about climate change. About 64.5% observed unexpected precipitation, and 97.5% percent said the temperature increased due to climate change. Such changes disturbed crop production, as mentioned by 83.0% of the respondents, and about 62.5% observed food safety. While 82.5% were applying adaptive strategies to deal with climatic issues on their own, they still needed the active participation of the government to assist farmers in coping with climate change.

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INTRODUCTION

Climate change refers to long-term alterations in temperature, precipitation, wind patterns and other aspects of the Earth's climate system. These changes are primarily driven by human activities, especially the burning of fossil fuels, deforestation, and unsustainable agricultural practices, which increase the concentration of greenhouse gases in the atmosphere (Intergovernmental Panel on Climate Change, 2021). The rising levels of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) trap heat in the atmosphere, causing global temperatures to rise, a phenomenon commonly known as global warming.

Over the past century, the Earth's average surface temperature has increased by about 1.1°C and this trend is expected to continue if decisive actions are not taken (National Aeronautics and Space Administration, 2023). The effects of climate change are already being observed across the globe and include extreme weather events, melting glaciers, sea level rise and disruptions in rainfall patterns.

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change which has a direct or indirect effect on personal life and brings changes in the structure of the atmosphere globally, and natural variability which is observed over a comparable period (Zeb et al., 2013). Developing countries like Pakistan are particularly vulnerable to the impacts of climate change due to their high dependence on agriculture, limited resources for adaptation, and increasing population pressure. Pakistan ranks among the top 10 countries most affected by climate-related disasters over the past two decades (Germanwatch, 2021). Changes in temperature and rainfall in Pakistan have led to significant challenges for farmers, such as reduced crop yields, loss of livestock, food insecurity and economic instability.

Variations in climatic conditions, along with occasional rainfall, are considered climate change. Many factors, such as deforestation, ignition of gasoline pollution because of emissions from automobiles, home-based chimneys, industrial

depletion and building and construction goods-making firms are associated with the reasons for atmospheric changes. With the expansion of the Industrial Revolution and the progression in different fields in the world, climate change occurred adversely. The outflow of some toxic emissions from electronics and other everyday beneficial kinds of stuff is adding to the unstable atmosphere (Shakoor et al., 2011).

Other South Asian countries, Pakistani rural people, depend entirely on agriculture, directly or indirectly, to secure their livelihood. The livelihood activities of low-income communities in rural areas are in danger due to the risks and vulnerabilities of climate change. Agriculture of Pakistan is also in danger due to the sudden climate changes, which is the livelihood source of almost 40% of its population. This sector adds up to 20% of the Gross Domestic Product (Government of Pakistan, Economic Advisor's Wing, Finance Division, 2019) historical climate changes have negatively impacted many regions globally. These shifts raise significant concerns due to their potential to directly and indirectly influence the economic conditions and policy decisions in the highland areas (Fahad and Wang, 2018).

Pakistan is facing many challenges to ensure livelihoods, such as low production of crops, soil erosion, water-logging and salinity, natural risks, reduction in the size of farm landholding due to inheritance, price variability of farm expenditures, etc. Among such threatening problems, climate change also stresses rural employment opportunities and creates explicit impacts on the lives of the poor community (Deressa et al., 2009).

Agricultural practices are assumed to be very delicate to sudden fluctuations in atmospheric conditions and also sensitive to constant fluctuations in the atmosphere. It is essential to evaluate the relationship between agriculture and climatic variations as a result of ever-increasing pressure exerted by the population and demand for agricultural commodities. Due to changes in atmospheric conditions, crops are expected to be damaged. Violent temperatures and unexpected rainfalls will change crop production by disturbing weed development, altering the water conditions and nutrients of the croplands (Consolacion et al., 2021). Undoubtedly, farming has been one of the primary occupations for people worldwide and is considered not only a source of food and grains but also a source of crude agricultural products for the manufacturing sector. The world's population is expected to grow from 6.7 billion to 9 billion by 2050. There are two regions in the world, South Asia and sub-Saharan Africa, which are increasing rapidly (Bruinsma, 2009).

Pakistan is at a specific risk of confronting the evil effects of consistent variations in climate. Pakistan is additionally one of the twelve nations which are considered to be highly susceptible to climate change and have a higher level of opportunities to better the conditions (Briscoe et al., 2008). Climatic variations and the amount of carbon dioxide in the atmosphere are the leading causes of low crop production. An increase in carbon dioxide accumulation alone actively supports the plant development process in order to boost production capacity. But apart from this, the expected change in precipitation and temperature tamper with the yield of crops, by expanding the plant growth ability, changing the water and minerals composition and increasing weed strain.

The economy of Pakistan is essentially agricultural and very sensitive to climate change. Due to variability in floods, droughts occur due to delayed monsoon rains. Because of this, water demands, food availability and energy requirements in Pakistan are at significant risk (Ladd and Suvannunt, 1976).

Pakistan's Food Security has been put in danger, and different factors, such as desertification of lands, frequent growth of pest invasions, increased waterlogging, and calamities, have caused a decrease in crop yields per year. As indicated by projections, with only a 1°C hike in temperature, wheat production in Pakistan is likely to drop by 6-9%. A significantly lesser ascent in temperature will seriously affect cash crops like cotton and mango (Mustafa, 2011). Pakistan is ranked as the third most vulnerable country to climate change. The government is experiencing dangerously high temperatures, which are particularly affecting rice production. As a result, rice yields are expected to decline significantly. While some mountainous regions of Pakistan might experience certain advantages from rising temperatures, the arid and semiarid areas will likely suffer severe negative impacts from climate change (Intergovernmental Panel on Climate Change, 2023).

A study conducted by Nasir et al. (2019) at the Institute of Agricultural and Resource Economics (IARE), University of Agriculture, Faisalabad, Pakistan, assessed the socioeconomic impacts of climate change on current and future agricultural production systems in Punjab. The results revealed that cotton production would be significantly negatively affected due to its high vulnerability to climate variability. Conversely, wheat production appeared less sensitive to climate change and, in some General Circulation Models (GCMs), showed potential benefits from increased atmospheric carbon dioxide concentrations (Nasir et al., 2019).

Akbar and Gheewala (2020) used ArcGIS to investigate historical and predicted spatial and temporal changes in climatic parameters and their impact on cotton and sugar cane yields in the southeastern region of Punjab, Pakistan.

They found that temperature changes could reduce crop yields, especially cotton and sugar cane, by 6% and 16% per year, respectively, in the distant future.

Pakistan's livestock sector is 60.5% of the country's agriculture production and 11.2% of the gross domestic product (GDP). It assists around eight million households residing in rural setups and who are also involved in rearing livestock (Government of Pakistan, Economic Advisor's Wing, Finance Division 2019). Widespread pastures and meadows in the homeland help the animal rearing department, and it is estimated that 60% of the land is utilized as pastures in Baluchistan, an arid and semiarid region of Sindh and Punjab and the northern areas of Pakistan. Such particular meadows and Greenlands assist about ninety-three million animals. In Baluchistan alone, around 87% of the population derives their livelihood from livestock (Ahmad et al., 2012). While adequate proof is accessible on how climate change affects yields in the agriculture segment, almost no evidence is available in the literature on how climate change influences the dairy system of the world (Thornton et al., 2015). The changing atmosphere additionally expands the occurrence of infection and mortality in domesticated animals (Rojas-Downing et al., 2017) and causes a decrease in livestock's productive capabilities. Diseases emerging from climatic changes in animals are evident throughout the globe, undermining the income, livelihood and food security of the people residing in the countryside of the third world (Rahut and Ali, 2018).

In the underdeveloped nations, the adoption approach for agricultural systems in Pakistan is extremely low due to the absence of fundamental infrastructure and effective policy measures. Serious intentions are compulsory for developing and enforcing effective adaptation plans with a special focus on the agricultural sector. For this purpose, efforts from the national and local levels are needed. It requires massive investments at the national level, in the creation of new adaptation schemes and unified disaster risk management strategies at the regional level (Bryan et al., 2013). Concerning this, the role of other participants in developing the agriculture sector is also crucial, such as agriculture scientists, policymakers, farmers, and the participation of the public and private departments (Howden et al., 2007).

While developing adaptation strategies to minimize the impacts of environmental change on agricultural zones, the primary focus should be on people's livelihoods. The objectives can only be achieved by implementing adaptive strategies at the local level and harnessing the resilience capacities of the farmers towards climatic variations (Hiza, 2011).

LITERATURE REVIEW

According to Farooqi et al. (2005), Pakistan has experienced a rapid increase in annual average surface temperature of about 0.6–1.0°C since the early 20th century, particularly in the coastal areas, hyper-arid plains and arid mountainous regions. These temperature rises have been accompanied by a 10–15% decrease in summer and winter rainfall in the coastal belt and hyper-arid zones. The rain in the monsoon-affected humid and sub-humid areas has increased by approximately 18–32%. Balochistan has seen a 5% drop in relative humidity, while the southern part of the country has experienced a 0.5–0.7% increase in solar radiation.

Holmgren and Öberg (2006) discussed that the growth of rural states on the Earth, particularly in Sub-Saharan Africa, is affected by the unsafe impacts of environmental change. The fluctuation of the worldwide atmosphere is a sensible procedure that has been accepted all around. The random differences in arrangements of special factors have been observed in Sub-Saharan areas, for example, spreading infection, failure in rainfall and variations in the patterns of downfalls.

Alexander et al. (2006) examined climate extremes using data from 116 meteorological stations across Central and South Asia. Their analysis of precipitation and temperature data from 1961 to 2000 showed that both the warm and cold extremes of maximum and minimum temperatures have generally increased. Regarding rainfall, the data revealed minimal changes in extreme wet events due to inconsistent three-dimensional patterns, with some stations showing increases and others showing decreases. The total rain amounts showed limited variability; there was slight evidence of irregular fluctuations in extreme precipitation events. For places with nearly complete records from 1901 to 2000, recent trends in minimum temperature extremes aligned with long-term patterns, while changes in maximum temperature extremes appeared to follow a multi-decadal, variable climate trend.

Morton (2007) explored how climate change affects smallholder and subsistence farming. The study found that some of the most serious impacts of global climate change will be felt by people in developing countries, especially those relying on small-scale agriculture. Their vulnerability is due to their location in tropical regions and social, economic and policy-related challenges that limit their ability to adapt. However, predicting or modeling these impacts is

difficult for several reasons: (i) there is no consistent definition of smallholder or subsistence farming systems, making it hard to collect standard data beyond the national level; (ii) these systems are highly complex, vary by location, and often mix both farming and non-farming activities for survival; and (iii) they are exposed to a wide range of climate-related and non-climate stressors. The study also reviews recent research on these systems, proposes a framework to understand the different types of impacts in a more integrated way and highlights areas where further research is needed.

Intergovernmental Panel on Climate Change (2014) concluded that the global temperature of the Earth has risen by 0.6 ˚C in the mid-19th century and projected to reach 1.1 ˚C and 6.4 ˚C over the 21st century. Temperature is increasing rapidly nowadays with the opening period. The Intergovernmental Panel on Climate Change depicted that the most noticeable temperature of the Earth has been confirmed from 1995 to 2006, and a significant rise in this impact around the world. Floods in Pakistan indicate the environmental implications throughout the sphere. The snow in glacial zones is melting speedily, and specifically referencing the explanations of IPCC, a gentle increase in temperature of the Himalayas is expected, which can create severe downpours in Pakistan within the coming years.

Biggs et al. (2008) have demonstrated in their research that an increase in diseases and a pronounced decline in periodic rainfall due to climate change will finally result in low agricultural productivity on the land of the Sahara (Africa). According to the program introduced by the Millennium Ecosystem Assessment, a prominent environmental assessment model (IMAGE) was utilized to examine the changes in climate and future land use in southern Africa. Rural societies of Africa are particularly associated with farming areas. The degree of agricultural development and the subsistence of people living in rural areas are entirely affected by the implications of environmental change.

Ayers and Forsyth (2009) directed the scientific indication for climate change and its futile moments for impoverished countries and verified the adverse outcomes of climate change for rural people. Regional environmental sciences are almost helpless towards climate modification, and these changes must be controlled in connection with ecological change. Environmental and human resources are naturally affected by atmospheric variations, which produce upward outcomes. The agrarian society of Zimbabwe and its livelihood are exposed to the climatic situation.

International Food Policy Research Institute (2009) presented a physical indication of weather variation and its influence on the number of crops. Their creative hydrology ratio effect is cast off to the amount of influence. Watered harvests are seeded and self-possessed. Their structural, as well as inner changes in cultivation water, need a farming request of liquid. The distressing consequences and results occurred in East Asia due to water scarcity; the rice-planting areas have been weakened by 4.8% in the last period, and income creation declined by 6.9% due to the temperature rise. Wheat, Rice and Maize are being affected due to H_2O pressure in East Asia and its definite provinces. Production of grain will drop according to this experiment.

Pacifici et al., (2015) described that according to numerous readings and reports, Pakistan is one of the highly vulnerable nations affected by climatic variability. Pakistan is ranked 12th in the Worldwide atmospheric hazard list regarding experience to various extraordinary ecological procedures from 1993 to 2012 (Kreft and Eckstein, 2013). Pakistan is also included in the rundown of 12 profoundly recognizable nations to bear fluctuation in the atmosphere by the World Bank. Pakistan is an Agro-based low-cost nation where farming funds around 21.4% of GDP, employs about 45% of the total workforce and offers revenue for 62% of the agrarian people (Abid et al., 2015).

Nath and Behera (2011) argued that rapid climate change has altered the stable conformity between nature and man. This is even more so in the areas that are usually continuously sensitive. The study identified that the underprivileged nations and societies are anticipated to endure more due to their geographical positions, low institutional efficiency, obscure payoffs, and higher dependence on climate-sensitive sectors such as agriculture. Regardless of whether atmosphere alleviation plans are executed appropriately, there will be some warming because of dormancy of outflows previously discharged. Accordingly, there is a solid agreement about the need for adjustment to changing climatic conditions. Adjustment is accepted to upgrade the flexibility against expanding atmospheric fluctuation.

RESEARCH METHODOLOGY

This study is based on a realist view, which means it believes that climate change and its effects on agriculture and rural life are real and can be measured. The study is explanatory. It tries to explain how climate changes, like shifts in rainfall and temperature, affect the crops, livestock and income of rural farmers. It also looks at how farmers are trying to cope with these changes and what kind of support they need from the government or other institutions. The research was conducted in District Muzaffargarh, located in the southern part of Punjab, Pakistan. It is known for its

fertile land and is famous for growing citrus fruits and mangoes. The climate is mostly dry with very hot summers and mild winters. The area experiences extreme temperatures, heavy dust storms and low average rainfall of about 127 mm annually. A multistage sampling method was used to select the sample for the study: In the first stage, one tehsil (Kot Adu) was selected randomly from the district. In the second stage, four union councils were chosen randomly from the selected tehsil. In the third and final stage, one village was selected from each union council. From each of the four villages, 50 respondents were selected, making a total sample size of 200. The data was collected using a structured interview schedule. This tool included questions related to climate change awareness, its impact on agriculture and livestock, income changes and adaptation strategies used by farmers. The interview schedule was used to collect data face-to-face from the respondents. The collected data were entered and analyzed using the Statistical Package for Social Sciences (SPSS). The chi-square test was applied. This helped to check whether climate change significantly affected different aspects of rural livelihoods.

RESULTS/FINDINGS

Table 1: Socioeconomic characteristics of the respondents

	Categories	Frequency	Aggregate	Cumulative %age
Educational level	Illiterate	26	13.0	13.0
	Primary	32	16.0	29.0
	Upto Matric	92	46.0	75.0
	Above Matric	50	25.0	100.0
Primary source of income	Farming / Vegetables / Fruit growing	135	67.5	67.5
	Livestock	7	3.5	71.0
	Farm Labour	10	5.0	76.0
	Job	28	14.0	90.0
	Business	20	10.0	100.0
Monthly income	Upto 15000 PKR	71	35.5	35.5
	Upto 35000 PKR	108	54.0	89.5
	More than 35000 PKR	21	10.5	100.0
Landholding size	Up to 5 Acres	74	37.0	37.0
	6-10 Acres	61	30.5	67.5
	Above 10 acres	37	18.5	86.0
	No Land	28	14.0	100.0
Characteristic/nature of the land	Barani//Rainfed	5	2.5	2.5
	Canal/Irrigated	30	15.0	17.5
	Tube-well	23	11.5	29.0
	Mixed	114	57.0	86.0
	Have no land	28	14.0	100.0

Socioeconomic characteristics are described as the social status of an individual living in a society. These characteristics, age, Education, Income level, Family type and Occupation play a crucial role in research findings because every individual provides answers according to their knowledge and experience. Table 1 shows that the majority, 46.0% of the respondents, have an educational background up to matric, and about 67.0% of the respondents' primary source of income was farming/vegetables/fruits. More than half, 54.0% and a little more than one-third, 35.5% originate from monthly incomes of up to 35000 PKR and up to 15000 PKR, respectively. According to the variable 'total land holding size' for agriculture activities, around 37.5% owned up to 5 Acres, and another 30.0% had 6-10 acres. Over half, 57.0% of the respondents have mixed types of land, tube-well, canal, irrigated, and only 15.0% obtained land with canal capability.

Table 2: Change in rainfall patterns and temperature due to climatic variations

		Increase in rainfall		A decrease in rainfall		No change		Total	
		Frq,	%age	Frq,	%age	Frq,	%age	Frq,	%age
Change in rainfall patterns	In summer	7	3.5	191	95.5	2	1.0	200	100
	In winter	182	91.0	11	5.5	7	3.5	200	100
	Unexpected rainfall	180	90.0	18	9.0	2	1.0	200	100
	Monsoon rainfall	19	9.5	154	77.0	27	13.5	200	100
Temperature variation	In summer	196	98.0	4	2.0	0	0.0	200	100
	In winter	195	97.5	4	2.0	1	0.5	200	100

Climate change, along with more frequent and extreme weather episodes, has long-lasting implications on the livelihood of people residing in the agricultural communities of the whole world (Burke and Emerick, 2016). For the agriculture of Pakistan, reasonable precipitation and proper temperature are required for the growth of different crops. The first part discusses rainfall variations that occurred due to changes in climatic situations, where a larger

proportion of the respondents noticed a decrease in rainfall during the summer season, while on the other hand, in the winter season, the rainfall increased, as observed by 91.0% of % respondents in the study area. The perception of unexpected rain and monsoon rainfall was recorded by 90.0% and 77.0% of the defendants, respectively. The second part provides the viewpoint of the respondents on temperature variation resulting from climatic changes, where the majority of the respondents, 98.0% observed a sudden hike in temperature in both seasons (summer and winter).

Hypothesis

Hypothesis Table 1: The higher the impacts of climatic variation on crop production, the higher will be the effects on rural livelihood.

Impacts on Crop Production	Effects on Rural Livelihood		Total
	Agree	Disagree	
Yes	88	14	102
	86.3%	13.7%	100.0%
No	78	20	98
	80.0%	20.0%	100.0%
Total	166	34	200
	83.0%	17.0%	100.0%

Chi-Square Tests	Value	Df	Sig. (2-sided)
Pearson Chi-Square	6.051	1	.017
Likelihood Ratio	1.587	1	.208
Linear-by-Linear Association	1.582	1	.209
Gamma	0.258		
N of Valid Cases	200		

Chi-Square = 6.05,1[a], df = 1, P-value = 0.017*, Gamma = 0.258
* = significant, df = Degree of freedom

Increase in global temperature, which is the leading indicator of climate change, the average production of major cereal crops, as well as fruits and vegetables, on which the livelihoods of rural people depend, is reducing rapidly. The results of the above table depict an association between crop production impacted by climate change and rural livelihood. The chi-square value 6.051 shows a significant relationship with the P-value (0.017). The Gamma value 0.258 also describes a positive association in the abovementioned variables. So, the Higher the impacts of climatic variation on crop production, the higher the effects on rural livelihood are acknowledged. Ateeq-Ur-Rehman et al. (2018) conducted a study to examine the impacts of environmental modification on the rural livelihood of farm families in Pakistan. The data explains that environmental change has consistently impacted health and ecological life, as expressed by 45.4% of the respondents. About one-third, 31.4% shared their view that climate change had influenced the crop yield and the livelihood activities of the respondents. Janjua et al. (2010) estimated the negative impact of carbon dioxide on wheat supply in Punjab. However, rainfall and temperature may have different implications in rain-fed and irrigated areas on crop production.

Hypothesis Table 2: Higher impacts of climatic variation on livestock will be on rural livelihood.

Impacts on Livestock	Effects on Rural Livelihood		Total
	Agree	Disagree	
Yes	131	20	151
	86.8%	13.2%	100.0%
No	35	14	49
	71.4%	28.6%	100.0%
Total	166	34	200
	83.0%	17.0%	100.0%

Chi-Square Tests	Value	Df	Sig. (2-sided)
Pearson Chi-Square	6.159	1	.013*
Likelihood Ratio	5.637	1	.018*
Linear-by-Linear Association	6.159	1	.013*
Gamma	0.448		
N of Valid Cases	200		

Chi-Square = 6.159[a], df = 1, P-value = 0.013*, Gamma = 0.448
* = significant, df = Degree of freedom

Climate change will impact livestock productivity, mainly due to high temperatures. These include physiological stress on animals, productivity losses (milk and meat), stress on conception and reproduction; climate-related disease epidemics, reduced productivity of fodder crops, decreased quality and palatability of forages and increased water requirements of animals and fodder crops. The above table represents an association between livestock

vulnerabilities faced by climatic variations and their effect on rural livelihood. Chi-square value 6.159 indicates a significant P-value 0.013 association as climatic changes were affecting livestock health and production, which ultimately affects rural livelihood. The Gamma value (0.448) also suggests a positive connection between the above factors. The Higher the impacts of climatic variation on livestock, the higher the effects on rural livelihood. This study was conducted by Abbas et al. (2019) to check the influence of climate change on the dairy sector in Pakistan. The comprehensive data set was collected from 200 farmers. The study found that farmers considered drought as one of the significant climatic risks which severely affect all aspects of dairy production. In order to estimate the perceived impacts of the climatic extreme event on milk production, an ordered Probit model was applied, and it was found that climate change had a high adverse effect on milk quantity in the study area.

DISCUSSION

The agriculture of Pakistan is in danger due to sudden climate changes. Pakistan is an agricultural state, and around 40% of its population lives from farm activities. This sector adds up to 20% of the Gross domestic product (Government of Pakistan, Economic Advisor's Wing, Finance Division, 2019). More than half of the respondents (62.0%) derived their income from farm activities. (3.5%) people earn their income from livestock (5.5%), secure their livelihood from vegetables and fruits (5.0%), make money from farm labour (10.0%), and acquire earnings from the business. Safdar et al. (2014) expressed that Pakistan is a famous nation in agribusiness. Just 5% of the land is secured by trees and timberlands. Numerous districts have a normal high temperature. In Baraani, the hilly and northern regions of the Punjab experienced heavy losses to yield in agriculture and livestock infrastructure caused by floods and people residing in these areas are at an exceptional risk. A significant proportion (98.5%) of the respondents heard about climate change, and there were only 1.5% of people who said "NO" to that. (40.5%) thought that the leading cause of variation in the climate situation was human activities. About one-third (29.0%) and a quarter (25.5 %) perceived deforestation and natural phenomena, respectively. Only 5.0% responded to overpopulation. Hijioka et al. (2014) decided that climate change is a universal atmospheric exigency which needs improvement and attention. Underdeveloped nations are presumed to face the harmful impacts of environmentally induced events, for instance, a trim level of variation in their surroundings. By the standards of the 21st century, it is estimated that temperature variation can badly distress international food safety. Little more than half (51.5%) of the respondents thought that there was a slight decrease, and 3.0% thought that there was no change in land fertility as a result of a change in the atmosphere. Climate change is now widely recognized as a global reality. Its rapid progression threatens human life, income sources, food security, and public health worldwide (Intergovernmental Panel on Climate Change, 2023).

Most (96.0%) respondents have observed environmental changes due to climate variations. Those who did not see any changes related to climate change in their locality were only 6.0%. Biggs et al. (2008) have demonstrated in their research that an increase in diseases and a pointed decline in periodic rainfall due to climate change will finally result in low productivity of agriculture on the land of the Sahara (Africa). A little more than half (51.5%) of people thought that there was a slight decrease, and 3.0% thought that there was no change in land fertility due to a change in the atmosphere. Morton (2007) investigated the effects of climate change on smallholder and subsistence agriculture, highlighting the unique vulnerabilities and adaptive challenges faced by these farming systems, particularly in developing countries. A majority proportion (83.0%) of respondents believed that variation in climate change harmed crop production, and 17.0% noticed that no change occurred in crop production due to climate variations. Nath and Behera (2011) argued that rapid climate change has altered the stable conformity between nature and man. Luqman et al. (2017) concluded that Pakistan is among those countries highly exposed to negative changes because of its geostrategic location, dense population and low technological resource base. Ateeq-Ur-Rehman et al. (2018) led an examination to observe the impacts of environmental modification on the rural livelihood of farm families in Pakistan. Fellmann et al. (2018) examined the significant challenges in integrating agriculture into climate change mitigation policy frameworks, emphasizing the complexities of aligning agricultural practices with environmental sustainability goals. Abbas et al. (2019) determined the influence of climate change on the dairy sector in Pakistan.

CONCLUSION

This research concluded that a significant proportion of people were affected by the calamities caused by climate change. Nowadays, people know the term Climate Change and have some basic information about it. Farmers' agricultural activities, health, proper access to balanced food, livestock production and economic resources were greatly disturbed by the fluctuations in environmental change. Variations in rainfall patterns, such as an increase in unexpected rains and a decrease in precipitation in regular seasons, negatively impact crop yield. Due to the temperature rise, the growth and production of major crops (wheat and cotton) in the studied area were drastically

decreased. Climate change significantly reduced crop yields, impacting rural livelihoods (p = 0.017). Livestock production was also negatively affected by climatic variations (p = 0.013). Farmers were intended to change the crop patterns due to the failure of the seasonal crops. Likewise, farming, livestock and their production were also impacted as fodder for livestock was reduced and their production capacities were decreasing with the severe unnatural conditions. Due to lower crop yields, the monthly income of the farmers has declined, and they are unable to fulfil the expenditure of the households in a meaningful way. The effects of undesirable events of environmental change are more far-reaching, and in response to climate change, the majority of farmers were applying adaptive measures on their own. The techniques used by farmers were the plantation of trees in their cropland, changing the sowing pattern, cultivation of weather-tolerant crops and a mixed cropping scheme. This study summarizes that promoting climate change on a large scale among people living in remote rural areas by the government is essential and necessary.

POLICY-BASED RECOMMENDATIONS

- Introduce drought and heat-tolerant crop varieties suited to local climate conditions.
- Promote adaptive farming techniques like mixed cropping and efficient irrigation systems.
- Strengthen agricultural extension services for regular farmer training and support.
- Launch a large-scale tree plantation and promote agroforestry practices.
- Provide low-interest agricultural loans, subsidies and crop insurance.
- Improve local weather forecasting and early warning systems for farmers.
- Ban unregistered and harmful pesticides to protect health and the environment.
- Conduct awareness campaigns about climate change in local languages.
- Engage NGOs and local institutions in community-based adaptation projects.
- Develop district-level policies for climate-resilient and sustainable agriculture.

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