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Farmers' Perception of Climate Change and Adaptation Strategies in Jaffarabad District of Balochistan

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Abstract
Climate change is a pressing global issue with far-reaching implications for agriculture, particularly in vulnerable regions like Balochistan, Pakistan. This study explores farmers' perceptions of climate change and their adaptation strategies in the Jaffarabad District of Balochistan, Pakistan. Primary data were collected through face-to-face interviews using an interview schedule, with a sample size of 124 farmers. The findings of the study revealed that a significant majority (67%) were aware of climate change and its adverse impacts. Most farmers (73%) perceived an increase in temperature, 71% observed fluctuations in rainfall patterns, and 62% experienced prolonged droughts. To mitigate these challenges, farmers adopted various strategies, including adjusting farming practices (73%), changing crop varieties (72%), and diversifying cropping patterns (68%). However, the effectiveness of these strategies was often hindered by resource constraints and limited access to modern technologies. The study underscores the urgent need for targeted interventions, such as improved extension services, capacity building, and access to climate-resilient technologies, to enhance farmers' adaptive capacity and ensure the sustainability of agriculture in the region.

Keywords: Climate Change, Farmers' Perceptions, Adaptation Strategies, Agriculture, Balochistan, Pakistan

Introduction
The weather variables such as temperature, rainfall, clouds, humidity, and wind averaged over a long time are attributed to the climate of a region (NASA, 2011). In this respect, climate change can be referred to as a change in temperature, rainfall, cloud, humidity wind, etc. that lasts from decades to millions of years. (IPCC, 2007a). Climate change has attracted the attention of stakeholders of almost all fields and is threatening to cause serious long-term impacts on human society all over the world which differ in different areas, farming systems, households, and individuals (Sahu and Mishra, 2013; Jiri *et al*., 2015). It is a threat to life that heavily affects water resources, coastal regions, freshwater habitats, vegetation, agriculture, forests, snow cover, and geological processes such as melting, land sliding, desertification, and floods consequently having long-term effects on food security and human health (Malla, 2008). Climate change is generally caused by global warming which is a result of increased concentration of greenhouse gases especially over the last century (Shivamurthy, 2013; Riedy, 2013; Hussain *et al*., 2005). It is highly believed that humans are responsible for the higher concentrations of greenhouse gases that cause global warming and associated climate change since 1750. It is estimated that approximately 50% of anthropogenic greenhouse gas emissions occurred in the last 40 years

since 1750. Though, climate change is a global phenomenon; however, the impacts are observed more in tropical and subtropical regions because of their higher exposure to climate shocks paired with lesser ability to mitigate and adapt against the vulnerabilities of climate change (IPCC, 2007 a & b). The majority of the population in developing countries lives in rural areas and depends on agriculture and related activities for their livelihood (Nyanga *et al*., 2011). Climate is the main determinant factor of agricultural productivity (Shivamurthy, 2013). The impact of climate change is felt more on agriculture as it mostly depends on climatic variables such as temperature and rainfall (Lobell and Field, 2007). Climate change has greatly modified temperature, rainfall, hydrological cycles, water resources, crop and grazing land, and livestock across the world (IPCC, 2007a; 2014). Moreover, extreme climatic events such as floods and droughts can destroy the whole harvest. Even a minute change in the climate can affect the growth and yield of crops. The effect may be positive or negative depending upon the nature of the change where major determinants include changes in atmospheric Carbon Dioxide, changes in temperature and rainfall that result in changes in growing seasons, pests, diseases, and extreme climatic events like floods and droughts (Islam, 2017). Pakistan is considered to be one of the most vulnerable countries to climate change. Global Climate Risk Index (GCRI) ranked Pakistan 8th among the ten most climate-affected countries for the period of 2000-2019 (Eckstein *et al*., 2021). In 2011, the World Bank listed Pakistan as the 12th extremely climate-sensitive country (GFDRR, 2011). Balochistan is the largest province of Pakistan in terms of area. It lies in the South-West of the country between 220 – 320 North and 660 – 700 East. The climate of the province is semi-arid to arid with a mean rainfall of 200 – 350 mm per year whereas, in many parts of the province as low as 50 mm per year making rain-fed agriculture impossible which is one of the main sources of livelihood for people of Balochistan (PDMA, 2020).

The concentrations of greenhouse gases in the atmosphere as the result of climate change are anticipated to intensify the rainstorms, floods, long dry spells, droughts, and other extreme weather events that will affect differently in different areas of the world (Vellinga and Verseveld, 2000). Balochistan province has witnessed extreme weather events such as extremely hot temperatures (53.5°C in Turbat), frequent and prolonged droughts, and devastating floods in the recent past (Hameed *et al*., 2020; Naz *et al*., 2020; Ahmed *et al*., 2019). Like other regions of the country, climate change has shown adverse impacts on the agriculture sector of Balochistan too. The devastating floods in 2010 and 2012 turned thousands of acres of arable land into barren infertile land in Naseerabad, Jaffarabad, Jhal Magsi, Sibi, Musakheil, Loralai, Haranai, and Zhob. A total of 452, 588 acres of crops were reported to be destroyed in the aforementioned parts of the province (Baloch, 2013). Reductions in rainfall have resulted in declined water tables in many areas leading to changes in farming practices, farm areas, and farm yields. Several fruit orchards have vanished whereas a large number of people have migrated to other areas of the country (Rahmatullah and Nawab, 2019). The groundwater depletion and droughts have impacted the income, nutrition, and livelihood of the people in many areas of the province. The increased food prices in drought-struck areas have forced the people to reduce their food intake leading to malnutrition among people, whereas the depletion of fodder sources and reduced fodder yields have led to increased death of livestock. Furthermore, the water shortage has led to changes in farming practices and patterns in the province. The shortage in farm output has forced many farmers to either migrate or sell valuable assets at cut rates (IRP, 2019). Understanding farmers' perceptions of climate change and their adaptation strategies is crucial for identifying effective pathways to build resilience in Jaffarabad district. Research indicates that farmers are increasingly aware of climate-related challenges, such as erratic rainfall patterns and temperature variations, which significantly impact their agricultural practices. However, despite their awareness, many farmers face barriers to implementing adaptive measures, primarily due to limited access to resources, information, and technical support (Hussain and Bangah, 2017). In

response, farmers have adopted various strategies, such as altering sowing dates, diversifying crops, and utilizing traditional water conservation techniques, though these adaptations often remain suboptimal without broader institutional support and infrastructure improvements. Therefore, assessing these perceptions and strategies is essential to designing targeted interventions that enhance the adaptive capacity of farmers in the region. Farmers' perceptions of climate change and their adaptation strategies are crucial for understanding their responses to changing environmental conditions in Jaffarabad district. Many farmers acknowledge the shifts in weather patterns, such as changes in rainfall and temperature, and adjust their farming practices accordingly. However, the capacity to adapt varies due to factors like resource availability, knowledge, and access to technologies. This study aims to assess how farmers perceive these climate changes and the strategies they employ to cope with these challenges, providing valuable insights for targeted adaptation interventions.

Material and Methods

This section describes the technical aspects of this study including the universe of the study, sample size, data type & source, and analytical techniques used to derive inferences.

Universe of the study

The district Jaffarabad of Balochistan province was the universe of this study. The district Jaffarabad lies 67°37’36” - 69°07’39” East Longitude and 27°56’3” - 28°40’26” North Latitudes with an area of 2,445 square kilometers. It consists of 3 Tehsils and 38 Union Councils. The headquarters of the district is in Dera Allah Yar Tehsil, commonly known as Jhatpat. The population of the district as per the 1998 Census was 4,32,817 (Now 5,13,813: PBS, 2017). The climate of the district is pleasant in winter while extremely hot and humid in summer. Major Rabi Crops of the district include wheat, barley, rapeseed/mustard, chickpea, pea, lentil, canola, fodder, and vegetables. While major Kharif crops include rice, sorghum, millet, maize, sesame, mungbean, mash bean, moth, onion, potato, melon, chili, coriander, guar seed, sugarcane, fodder and vegetables (GoB, 2011).

Sample Size

The sample size for any study bears prime importance as a too-small sample size does not reflect the true picture of the population, whereas too large sample size may result in higher time and financial costs. Keeping in view these aspects, a sample size of 124 farmers was selected from Jaffarabad district. The sampled farmers were full-time farmers who practiced farming for their livelihood.

Data Type & Source

The data for this study was primary data which was sourced directly from the sampled respondents through face-to-face interviews using a well-developed interview schedule.

Data Analysis

The collected data was put into statistical software Stata v. 18 for analysis. Simple counts and percentage methods were used to derive inferences.

Results and Discussion

This section presents the results in tabulated form showing counts and percentages. In the first section, the demographic aspects of the sampled respondents are presented while in the second and third sections, their perception of climate change and adaptation strategies are presented respectively.

Demographic Characteristics of the Sampled Farmers

Integration of demographic information of sampled respondents is essential for any research study, as it helps in understanding the factors influencing their behavior. Demographic details like age and education provide a deeper understanding of the studied population. Additionally, factors such as farming experience, tenancy status, and farm size contribute to interpreting the findings. Overall, including demographic information enhances research outcomes, offering a clearer insight into the factors shaping individuals within the sample. In this context, the Table 1 provides the demographic characteristics of the sampled farmers from district Jaffarabad. The results presented in Table 1 show that the majority of the sampled farmers were between the ages of 26 and 45 years, with the largest group (31%) being in the 36-45 age range. A considerable portion of farmers, 28%, were in the 26-35 age group, indicating that younger individuals were also actively involved in farming. Only 10% of respondents were aged 25 years or younger, while 14% were above 55 years. This suggests that agriculture in the area was primarily managed by middle-aged individuals, with a smaller representation of younger and older farmers. Regarding educational background, a substantial portion of the sampled farmers, 31%, were illiterate, indicating that education levels among farmers varied significantly. However, 27% had achieved education beyond intermediate level, which shows that a significant portion of farmers had completed secondary or higher education. The remaining farmers had varying educational levels, with 17% having completed matriculation, and smaller percentages having completed primary or middle school. This highlights that while many farmers lacked formal education, a sizable proportion had attained at least secondary education. In terms of farming experience, the majority of the sampled farmers (37%) had between 11 and 20 years of experience. There was also a significant proportion (22%) with 1 to 10 years of experience, suggesting that a considerable number of newer farmers were involved in the region's agriculture. A smaller percentage of respondents had more than 30 years of farming experience, indicating that the area also had a good representation of seasoned farmers. The results further showed that most of the sampled farmers (73%) owned the land they cultivated, with 11% being tenants and 16% being both landowners and tenants. This distribution indicates that land ownership was the dominant form of land tenure in the study area, while tenant farming was less common. This suggests that a majority of farmers had control over their land, which could impact their farming decisions and adaptation strategies. Lastly, farm size data indicates that small-scale farming was prevalent in the study area. Nearly 40% of farmers operated farms of up to 10 acres, while 20% farmed between 11 and 20 acres. Larger farms, those over 30 acres, were less common, with only 13% of farmers cultivating 41 acres or more. This suggests that small-scale farming was more typical, and larger farming operations were relatively rare in the study area.

Table 1 Demographic Characteristics of the Farmers in the Study Area

Age		
Years	**Number**	**Percentage**
Up to 25 Years	12	10
26 - 35 Years	35	28
36 - 45 Years	39	31
46 - 55 Years	21	17
Above 55 Years	17	14
Total	124	100
Education		
Educational Level	**Number**	**Percentage**
Illiterate	38	31
Primary	16	13

Middle	8	6
Matric	21	17
Intermediate	8	6
Above Intermediate	33	27
Total	124	100
Farming Experience		
Years	**Number**	**Percentage**
1 - 10 Years	27	22
11 - 20 Years	46	37
21 - 30 Years	26	21
31 - 40 Years	12	10
41 - 50 Years and Above	13	10
Total	124	100
Tenancy Status		
Land Ownership	**Number**	**Percentage**
Owner	90	73
Tenant	14	11
Owner-cum-Tenant	20	16
Total	124	100
Farm Size		
Acres	**Number**	**Percentage**
Upto 10 Acres	48	39
11 - 20 Acres	25	20
21 - 30 Acres	23	19
31 - 40 Acres	11	9
41 - 50 Acres and Above	17	13
Total	124	100

Note: *The values in parenthesis are percentages.*
Source: *Survey Data Analysis (2021 - 2022)*

Farmers' Perception of Climate Change

Farmers' perceptions of climate change play a crucial role in understanding its impact on agriculture, adding depth to scientific studies on the issue. As primary custodians of the land, farmers observe firsthand changes in crop yields, water availability, and pest behavior, offering insights that may not be immediately visible in climate models. Their observations often serve as an informal early warning system, revealing local trends and challenges posed by climate shifts. Integrating these insights into research not only enriches climate impact assessments but also enables the development of adaptation strategies that are grounded in local realities. This recognition of diverse farmer experiences also informs the design of targeted, effective policies that address specific agricultural needs. Ultimately, farmers' perspectives build a bridge between scientific research and practical agricultural practices, fostering a collaborative approach to addressing climate change's complex challenges. In the context of the above, the following sections present an overview of the farmers' perception of climate change, and its effects in Jaffarabad are presented in Table 2. The results presented in Table 2 show that a significant majority of sampled farmers were familiar with climate change, with 67% acknowledging awareness of the phenomenon. This suggests that climate change is a concept widely recognized by farmers, indicating an understanding of its relevance to agriculture in the region.

In terms of specific climate impacts, 73% of farmers reported noticing an increase in temperature, which they associated with the changing climate. This high percentage reflects widespread concern about rising temperatures and their potential effects on crops and farming practices. Similarly, 71% of farmers observed fluctuations in rainfall patterns, with some reporting either less or more rainfall, which is a significant concern for crop production and water availability. The sampled farmers also recognized prolonged droughts and frequent floods as major climate-related issues. 62% of them identified prolonged droughts, while 71% acknowledged frequent floods, both of which are critical factors affecting water resources and crop yields. However, 48% of the farmers reported experiencing frequent hailstorms, a less common perception compared to other climate impacts, as only half of the farmers noticed this phenomenon. The perception of crop failures due to climate change was also notable, with 60% of farmers linking climate change to crop losses. Additionally, 63% of farmers reported an increase in pest and disease attacks, which they attributed to climate change, highlighting its effects on the prevalence of agricultural pests. Lastly, a significant proportion of sampled farmers (68%) acknowledged water shortages, linking this issue directly to the effects of climate change on water availability. Overall, the results indicate that farmers perceived various climate change impacts, especially those related to temperature, rainfall, and water resources, as critical challenges affecting their agricultural practices.

Table 2 Farmers' Perception of Climate Change in the Study Area

Farmers Perception	Farmers Response		Total
	Yes	No	
Familiarity With Climate Chang	83 (67)	41 (33)	124
Increased Temperature	90 (73)	34 (27)	
Unpredicted Rains	78 (63)	46 (37)	
Prolonged Droughts	77 (62)	47 (38)	
Less/More Rains	88 (71)	36 (29)	
Frequent Hailstorms	60 (48)	64 (52)	
Frequent Floods	88 (71)	36 (29)	
Crop Failures	74 (60)	50 (40)	
Frequent Pests & Disease Attacks	78 (63)	46 (37)	
Water Shortage	84 (68)	40 (32)	

Note: *The values in parenthesis are percentages.*
Source: *Survey Data Analysis (2021 - 2022)*

Farmers Adaptation Strategies

Examining farmers' adaptation strategies in the face of climate change is essential, as it uncovers the complex interactions between human agency and environmental pressures. Agriculture's deep interconnection with climate requires an understanding of how farmers manage shifting conditions. By analyzing their strategies, we gain insights into the resilience embedded within agricultural systems and discover sustainable practices that support broader climate adaptation and mitigation goals. Farmers, positioned at the forefront of climate impacts, utilize diverse methods to cope, highlighting the value of local knowledge and community-centered solutions. Studying these approaches not only aids in creating informed policies but also enriches our understanding of the delicate balance between human actions and environmental changes. Synthesizing such knowledge contributes to a more comprehensive understanding of climate change's complexities, fostering an informed, adaptive approach to the challenges that the agricultural sector faces. In the context of the above, the Table 3 presents an overview of the farmers' adaptation strategies that they practice to cope with the challenges of climate change and its effects in district Jaffarabad. The results presented in Table 3 show that sampled farmers

employed various adaptation strategies in response to climate change. The most common strategy was adjusting farming activities, with 73% of farmers adopting this approach. This suggests that many farmers adjusted their agricultural practices to cope with the changing climate, emphasizing the importance of flexibility in farming operations. Similarly, 72% of farmers changed their crop varieties and planting dates, indicating that they were actively modifying their crop selection and planting schedules to better suit shifting climatic conditions.

Diversifying cropping patterns was another widely used strategy, with 68% of sampled farmers implementing this approach. This diversification likely helps to spread risks and maintain agricultural productivity despite climate variability. While 50% of farmers planted beneficial or economic trees as part of their adaptation strategies, this was a less common practice compared to others. The relatively even distribution of responses (50% yes, 50% no) suggest that farmers were either unsure about or had limited opportunities for incorporating trees into their farming systems. In terms of land management, 56% of the sampled farmers reported changing the size of their cultivated land, possibly in response to changing environmental conditions or the availability of resources. Soil conservation techniques were practiced by 48% of farmers, reflecting a somewhat lower level of adoption, which could indicate either a lack of awareness or limited access to such practices. Shifting from farming to non-farming activities was another adaptation strategy, with 56% of the sampled farmers considering this option, possibly due to the increasing challenges posed by climate change. Diversification of livestock numbers and breeds was reported by 57% of the farmers, suggesting that livestock management was an important area of adaptation. Similarly, 60% of farmers practiced water harvesting techniques, indicating that water conservation was a priority for many in the face of changing precipitation patterns.

The sampled farmers also adapted by building water catchment areas (57%) and adjusting irrigation practices (56%), both of which are essential for managing water resources. Lastly, while 40% of farmers shifted to renewable energy sources, a significant majority (60%) did not adopt this practice, possibly due to financial constraints or a lack of access to renewable energy technologies. Overall, the findings of the study highlight that farmers employed a variety of strategies, with the most common adaptations focused on adjusting farming practices, water management, and crop selection, all aimed at mitigating the impacts of climate change.

Table 3 Farmers' Adaptation Strategies in the Study Area

Adaptation Strategies	Farmers Response		Total
	Yes	No	
Adjusting Farming Activities	90 (73)	34 (27)	124
Changing Crop Varieties	89 (72)	35 (28)	
Diversifying Cropping Pattern	84 (68)	40 (32)	
Changing Planting Dates	89 (72)	35 (28)	
Planting Beneficial/Economic Trees	62 (50)	62 (50)	
Changing Cultivated Land Size	70 (56)	54 (44)	
Practicing Soil Conservation Techniques	59 (48)	65 (52)	
Shifting from Farming to Non-Farming Activities	69 (56)	55 (44)	
Diversifying Number/Breed of Livestock	71 (57)	53 (43)	
Practicing Water Harvesting Techniques	74 (60)	50 (40)	
Building Water Catchment Areas	71 (57)	53 (43)	
Adjusting Irrigation Practices	70 (56)	54 (44)	
Shifting to Renewable Energy Sources	50 (40)	74 (60)	

Note: *The values in parenthesis are percentages.*

Source: *Survey Data Analysis (2021 - 2022)*

Conclusion and Recommendations

This study explored farmers' perceptions of climate change and their adaptation strategies in Jaffarabad District, Balochistan. The findings indicate that farmers were increasingly aware of the impacts of climate chan'e, particularly erratic rainfall, rising temperatures, and prolonged droughts. These climatic changes have adversely affected crop yields, water availability, and the overall agricultural environment in the region. The farmers reported facing challenges such as water scarcity and extreme weather events, including floods and droughts, which threaten the sustainability of farming. Farmers have adopted several strategies to cope with these challenges, such as adjusting planting dates, switching to drought-tolerant crops, and using traditional water conservation methods. However, the study suggests that these adaptations may be limited in effectiveness. These findings may be due to various factors, including possible constraints in resources, access to up-to-date information, and technological support, although these factors were not directly explored in this study.

Recommendations

Based on the findings of the study, the following suggestions are recommended to help farmers in Jaffarabad District better adapt to the challenges posed by climate change, ensuring the long-term sustainability of agriculture in the region.

- Agricultural extension services should be strengthened to provide farmers with up-to-date information on climate change and adaptation strategies, helping them adopt more effective measures for sustainable farming.
- Training programs should promote the adoption of climate-resilient agricultural practices, such as crop diversification, soil conservation, and water-efficient irrigation techniques, to enhance long-term productivity and resilience.
- Given the ongoing water scarcity issues, improving water management practices through rainwater harvesting, efficient irrigation methods, and rehabilitation of traditional water storage systems should be prioritized.
- Government and non-governmental organizations should collaborate to develop policies and provide financial support to farmers, facilitating access to climate adaptation technologies and improving infrastructure to address the challenges posed by climate change.
- Community-based adaptation approaches should be encouraged, where farmers can share knowledge, resources, and technologies to build collective resilience. Local institutions can play a key role in facilitating these initiatives.
- Awareness campaigns tailored to local conditions should be conducted to inform farmers about the impacts of climate change and practical solutions they can implement to improve their adaptive capacity.
- By implementing these recommendations, farmers in Jaffarabad District will be better equipped to adapt to the challenges posed by climate change, ensuring the long-term sustainability of agriculture in the region.

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