International Research Journal of Social Sciences and Humanities, Vol.:05, Issue:01,Jan-March,2026
PP:29-54

OPEN ACCESS
IRJSSH
ISSN (Online): 2959-1392
ISSN (Print): 2959-2887
www. irjssh.com

FARMERS' PERCEPTIONS, INDIGENOUS KNOWLEDGE, AND RISK ASSESSMENT OF CLIMATE CHANGE AND WATER SCARCITY IN ARID NORTHWEST PAKISTAN

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Abstract

This study investigates how small-scale farming communities perceive and respond to water scarcity and climate change in Pakistan's arid Pishin Lora Basin. Through household survey with 264 famers, the study finds that almost all farmers have observed climatic changes at local level. Their understand of climate change is often shaped by religious and cultural beliefs, mostly attributing such changes to natural cycles and divine will, rather than activities of humans. Such perceptions influence their actions: mostly take little responsibility or capability to play their role in mitigations. Digging more wells and going deeper for water is their main strategy to address water shortage which is an unsustainable and short-term solution. With little formal education and more focus on informal community networks for information, they have limited access to scientific knowledge and advanced climate-resilient agriculture techniques. The study elaborates a significant gap between local experience and scientific strategies of adaptation, arguing that effective climate policy needs to minimize this gap by integrating indigenous knowledge with scientific insights and focusing on deep-rooted perceptions to enhance community resilience.

Keywords: *Climate Change; Perception; Indigenous Knowledge; Small-scale farmers; Pishin Lora Basin.*

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INTRODUCTION

Climate change is on the most complex and critical challenges in the contemporary world, causing intensive threats to stability of the global environment, socio-economic conditions, food and human security. Particularly, it severely impacts the arid and semi-arid regions – with scarce water resources, fragile ecosystems and livelihoods that are highly dependent on climate sensitive field such as agriculture (IPCC, 2022). In the contexts of such vulnerability, the nexus between climate changes and human activities forms a risk cycle that increases poverty, social inequality and food insecurity. The northwestern regions of Pakistan including Balochistan province, are highly vulnerable to these conditions due to its agrarian economy, geographical exposure and limited adaptive capacity (Malik et al., 2012; Mirza, 2011). The Pishin Lora Basin – located in the arid zone of Balochistan, is facing critical conditions where recurrent droughts, erratic rainfall, and declining water tables are highly challenging the sustainability of small-scale farming system which is the backbone of local rural economies (Yousuf & Barrech, 2022; Shahid et al., 2004).

Effective and smart climate change adaptation requires not only technological invocation and scientific understanding but also profound focus on live experiences, knowledge systems and perceptions of those directly affected – such as small-scale farmers in this case. There is increasing focus on communities' and individuals' perceptions, interpretations and assessment of climate risk that basically outlines their behavior, response mechanism, decision making and resilience (Weber, 2010; Grothmann & Patt, 2005). In most of the rural zones of Global South, such perceptions are not formulated in isolation with scientifically guided narratives but are also deeply rooted indigenous and traditional knowledge, local cultural contexts, informal social networking, and religious beliefs (Berkes & Ross, 2013; Mercer et al., 2010). As a result, a significant difference can take place between local understandings of climatic shocks – usually attributing climate changes to fate, divine will and/or natural phenomena – and scientific reasoning on anthropogenic factors (Roco et al., 2015). Consequently, this gap of perceptions and understanding can affect

the acceptance of scientific technologies, mitigations actions and effectives of the climate policy interventions at large.

In the specific context of water scarcity, the perceptions of farming communities are further intricated by socio-economic, managerial and institutional factors. Findings of research studies reflect that in least developed areas such as Balochistan, water scarcity is usually perceived more as a result of poor resource management, inadequate infrastructure and governance failures as compared to climatic phenomenon solely (Khan et al., 2020; Briscoe & Qamar, 2006). This behavior of farmers reflects their perception of who is responsible and what they believe about more viable solutions–ranging from asking government to build dams to dependency on local traditions and spiritual rituals. It is, therefore, increasingly essential to understand such nuanced perceptions for framing climate resilient strategies and sound water governance that are not only technically effective but also socially legitimate.

Though, there is growing scholarly focus on climate behavior at global level, still huge gap remains in empirical investigation focusing on the arid zones like Balochistan, mostly on finding the link among water scarcity perceptions, indigenous knowledge and the adaptive behavior (Baloch et al. 2022). Biophysical or economic assessments is the focus of most of the existing literature – with less focus on the socio-cultural and behavioral aspects of decision-making process among farming communities (Abid et al., 2016; Abid et al, 2019). Additionally, there is paucity of research into how sources of information – formal media, informal networks in community, or religious leader – influence the establishment of risk perceptions and awareness in areas with lower literacy and limited access to digital sources.

The objective of this study is to address these gaps by exploring community perceptions, understanding, knowledge and risk assessment regarding water scarcity and climate change in the northwest arid zone of Pakistan, with particular focus on Pishin Lora Basin of Balochistan. The study aims to investigate how small-scale farmers perceive climatic variabilities, their causes and the segments responsible for it, and how such understandings affect their adaptation and resilience practices. By examining these questions, the research contributes to a more holistic and

context-sensitive understanding of climate adaptation, one that bridges local experiential knowledge with scientific insights and informs the development of more inclusive, participatory, and effective policy responses in some of Pakistan's most climate-vulnerable communities.

2. Literature Review

2.1 Climate Change and Agriculture in Arid Regions

Climate change is highly considered as a serious threat to agriculture sector globally, especially in the arid and semi-arid zones where limited water resources are available (IPCC, 2022). Studies highlight that increasing temperatures, rising occurrence of extreme weather events for example heat waves and changing patterns of precipitation are disturbing growing seasons, decreasing crop yields, and causing threats for food security (Lobell et al., 2011). In South Asian Countries, including Pakistan, it is projected that climate change will increasingly threaten water resources causing intensive water scarcity and will decrease the productivity of agriculture sector, particularly dependent on rain-fed agriculture (Mirza et al. 2005). In the northwest of Pakistan, the Pishin Lora Basin is already faced with lower rainfall, increased rate of evaporation and groundwater depletion that make the basin highly vulnerable to climate change impacts (Yousuf & Barrech, 2022; Ahmad et al., 2022; Halcrow, 2007).

2.2 Farmers' Perceptions and Risk Assessment of Climate Change

Adaptive responses to climate change among farming communities are highly dependent on their perceptions of climate change (Yamba et al., 2019; Ayeb-Karlsson et al., 2016; Weber, 2010). Studies indicate that perceptions are shaped by access to information, socio-cultural contexts, personal beliefs and direct experiences (Slegers, 2008). In many developing countries, farming communities report that they have been noticing temperature surge, variations in rainfall timing and more recurrent droughts (Maddison, 2007). Nevertheless, development of farmers' perceptions may not always be shaped by scientific data, for instance, some farmers my believe that climate change is attributed to supernatural forces and natural cycles as compared to anthropogenic factors (Haque et al.,

2022; Qasim et al., 2016; Roco et al., 2015). Studies claim that in Pakistan, many farmers are aware of climate change, however, their understanding of its causative factors and implications in long-term are still limited (Ali & Erenstein, 2017; Abid et al., 2016).

2.3 Indigenous Knowledge and Adaptation Practices

Indigenous Knowledge is referred to the locally thought cumulative understandings, beliefs and practices that are developed via experiences and transferred from generations to generations (Berkes, 2012). IK (Indigenous Knowledge) in climate adaptations can offer valued insights into water conservation, resilient practices of farming and disaster prediction (Pearce et al., 2015; Mercer et al., 2010). In arid zones, for example, crop diversification, traditional methods of rain harvesting and maintaining soil moisture have been practiced for centuries to cope with variability (Makondo & Thomas, 2018). On the other hand, it also challenging to integrate Indigenous Knowledge with scientific knowledge due a number of reasons such as undervaluation of local wisdom, institutional bottle-necks and lack of documentation (Nyong et al., 2007).

2.4 Water Scarcity and Institutional Challenges

In most of the arid regions, water scarcity is caused by both anthropogenic and climatic factors, including poor governance, over-extraction, lack of infrastructure and inefficient irrigation system (Molle & Mollinga, 2003). Water management, in Pakistan, often characterized by institutional inefficiencies (Javed, 2016; Qureshi, 2005), unequal water distribution and lower participation of farmers (Briscoe & Qamar, 2006). Farmers in Balochistan, more frequently, perceive that water scarcity is due to governance failures rather than climate change, attributing it to poor water budgeting and shortage of dams (Khan et al., 2023). Enhanced adaptation not only needs technological way out but also reforms in institutions and community participation in water governance (Nasrullah & Ainudddin, 2014; Pahl-Wostl et al., 2007).

2.5 Socio-Economic and Educational Barriers to Adaptation

Socio-economic determinants including income, education, access to information and landholding size significantly affect adaptive capacity farmers to climatic variability (Deressa et al., 2009). Limited access to

formal education and low literacy rates can restrain farming community's ability to access, understand and interpret climate information, engage in adaptation programs and adapt new technologies (Madison, 2007). Low literacy rates among small-scale farmers in the northwest of Pakistan hampers them with adaptation of modern agriculture techniques and scientific knowledge (Yousuf & Barrech, 2022). Moreover, cultural and religious beliefs can shape risk perceptions and preparedness to accept adaptive measures (Haque et al. 2022).

2.6 Communication and Information Networks

The role of information sources in shaping climate perceptions and behaviors is well-documented (Moser, 2010). In rural settings, informal networks—such as community gatherings, peer discussions, and local activists—often serve as primary channels for information exchange. However, these sources may disseminate incomplete or inaccurate information, leading to misperceptions about climate risks and solutions (Bidwell et al., 2013). The limited use of mass media and digital platforms in remote areas further restricts access to reliable climate information (Obonyo et al., 2025). Enhancing the quality and reach of climate communication is essential for building informed and resilient communities.

2.7 Theoretical Frameworks: Risk Perception and Adaptive Behavior

Theoretical models such as the Protection Motivation Theory (Rogers, 1975) and the Theory of Planned Behavior (Ajzen, 1991) have been used to explain how individuals perceive risks and decide to adopt adaptive measures. Risk perception is influenced by factors such as perceived severity, vulnerability, self-efficacy, and response efficacy (Grothmann & Patt, 2005). In farming communities, perceptions of low personal agency or divine control over climatic events can reduce motivation to engage in adaptation (Haque et al., 2022). Understanding these psychological and social dimensions is crucial for designing interventions that promote proactive adaptation (Yamba et al., 2019)

The existing literature underscores the multifaceted nature of climate adaptation in arid agricultural systems. While significant advances have

been made in understanding climatic impacts and adaptation technologies, less attention has been paid to the interplay between local perceptions, indigenous knowledge, and institutional contexts in shaping adaptive behaviors. This study contributes to filling this gap by examining the case of smallholder farmers in the Pishin Lora Basin, where socio-cultural, religious, and informational factors uniquely influence responses to climate and water challenges. By integrating insights from risk perception, indigenous knowledge, and institutional analysis, this research aims to inform more holistic and context-sensitive adaptation strategies.

3. Methodology

The study was explanatory in nature which employed a cross-sectional survey method to examine the perception of farmers, indigenous knowledge and risk assessment of water scarcity and climate change. The study was carried out in one of the most arid basins of Balochistan – the Pishin Lora Basin.

Small-scale farmers were interviewed through face-to-face interviews using structured questionnaire in two purposively selected districts of PLB: Pishin and Mastung. A total of 264 (Arkin and Colten, 1963) household heads were selected as sample size using UNICEF pencil-spin selection method and disproportionate stratified sampling technique for allocation of equal and adequate representation from both strata (Pishin and Mastung).

Data analysis was carried out using SPSS software. To summarize the quantitative data, descriptive statistics were computed which included frequency counts, percentages, range, mean and standard deviation. Correlation coefficient tests were performed to examine the relationship and direction between variables related to risk perceptions, understanding and knowledge.

4. Results and Discussion

4.1 Socio-economic Profile of HoHs (Small-scale Farming households)

Table 1 *Descriptive Statistics of Social Profile*

Variable		*Range*	*Mean*	*Std. Deviation*
Age of respondent (years)	*64*	*33-65*	*48.18*	*7.20*

Family size (Nos.)		*6-18*	*10.59*	*2.80*
Total number of literate members in family (above age of 10 years)	*64*	*0-10*	*2.03*	*1.68*
*Family income per anum (PKR)**	*64*	*400-2000*	*934.91*	*303.40*
Farm size (acres)	*64*	*2-5*	*4.36*	*.83*
Experience in agriculture (years)	*64*	*8-35*	*19.30*	*5.31*

**Data in thousands*

Source: Field survey

The average age of smallholder farmers in the study area was 48 years with a range of 33 to 65 years. The mean family size was 10.59 with a standard deviation of 0.83 and the range was 6 to 18 members per family. On average 2.03 family members were literate with a range of 0-10 and a standard deviation of 1.68. The average number of senior citizens (above 60 years of age) per household was 0.83 (range 0-3). Family income of smallholder farmers per year ranges between Rs. 400,000/- to Rs. 2,000,000/- with a mean income of almost Rs. 935,000/- and a standard deviation of almost Rs. 304000/-. Since, the target population of the study was smallholder farmers (having < 5 acres of farmland, according to World Bank, (2008), the mean farm size was 4.36 acres per household, with a range of 2-5 acres and the standard deviation is 0-83. Statistics show that number of smallholder farmers in Pishin is higher as compared to the Mastung district. The average experience in farming is 19.30 years with a range of 8-35 years and a standard deviation of 4.48.

4.2 Education Level

Data of field survey highlights that a huge majority of farmers are illiterate in Mastung (67%) while comparatively better (45%) in Pishin. Primary education is attained by 24 percent of farmers in Pishin while 18 percent in Mastung district. The trend of farmers towards religious

education in Pishin (18%) is higher as compared to farmers in Mastung (only 5%). The number of farmers with secondary or higher education is very low in both districts (13% in Pishin & 9% in Mastung).

This reflects that smallholder farmers have very less trend towards obtaining formal education and thus face difficulty in obtaining scientific knowledge and updates regarding climatic shocks and adaptation of modern climate resilient methods of farming which is also highlighted by Madison (2007). Additionally, lack of education and illiteracy has become a hurdle in accepting change and adaptation to climate change impacts.

4.3 Community Understanding and Risk Perceptions of Climate Change

Community understanding and risk perceptions of climate change, water scarcity, temperature trends, rainfall patterns and extreme weather events (EWEs) are significant factors in enhancing resilience to climatic shocks (Pearce et al., 2015; Mercer et al., 2010). Small-scale farmers in remote rural areas are the most vulnerable households. They largely rely on local knowledge to develop an understanding and perception of climate change and water scarcity. This study focuses to analyze farmers' understanding and risk perceptions of water scarcity, climate variability and climate change impacts. It also elaborates on the potential factors and the way these factors influence smallholder farmers' perceptions and adaptive behavior.

4.4 Source of Information for HH

The source of information is an important element in building community understanding and perception of climate change. Survey data elaborates that farmers' access to and their trends regarding the usage of sources of information to get updates on climate changes, hazards and weather trends. These sources also serve as means to get awareness, knowledge and improve understanding of climate-change related subjects. These sources can also develop perceptions of the community regarding climate change, risk factors, its effects and adaptations.

The statistics reflected almost half of small-scale farmers (47%) use multiple sources of information to get climate-related updates. A quarter of farmers (25%) rely on community informal meetings, discussions, and casual meet-ups with community people to be updated regarding climate-related subjects. Community activists are also a source to provide such

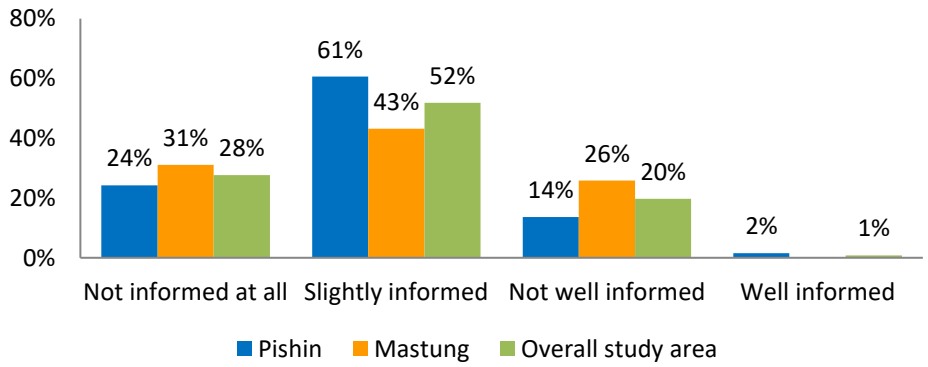
information to the farming community. In this study, 11% of farmers claim that they get climate-related information from social activists in the community. However, a lesser percent of farmers use single sources such as newspapers (6%), TV (5%), internet & social media (4%) and radio (only 1%).

Statistics elaborated that 36% of farmers use community meetings and social activists to develop their understanding, perceptions and knowledge of climate change impacts and risk factors. A significant perspective in this regard was observed that community-based sources of information are not very much reliable where inappropriate knowledge can also be shared. Consequently, poor understanding can be developed regarding climate change, risk factors and adaptive mechanisms.

4.5 Information Level about Climate Change

Awareness and understanding of climate change is a pre-requisite to dealing with climate change and enhanced resilience. Both scientific and indigenous knowledge provides the basis for an informed community. Figure 1 elaborates on small-scale farmers' level of information regarding climate change in both selected districts of the study area.

Figure 1 *Information Level about Climate Change*



Source: Field survey,

The overall statistics in Figure 1 illustrate that a big majority of farmers are not much informed about climate change. 28% of farmers reported that they are not informed about climate change at all. More farmers in Mastung

(31%) as compared to Pishin (24%) perceived they did not know about climate change at all. 52% of respondents claimed that they are slightly informed about climate change (which is a mean of 61% in Pishin and 43% in Mastung). 20% of farmers believed that they were informed but not well informed about climate change and its impacts. As minimum as less than 1% of farmers claimed that they were well informed about climate change. The findings reflect that the climate change-related knowledge of farmers does not show satisfactory conditions. This, eventually, gives birth to a variety of perceptions among the community.

4.6 Farmers' Observation of Climate Change at Local Level

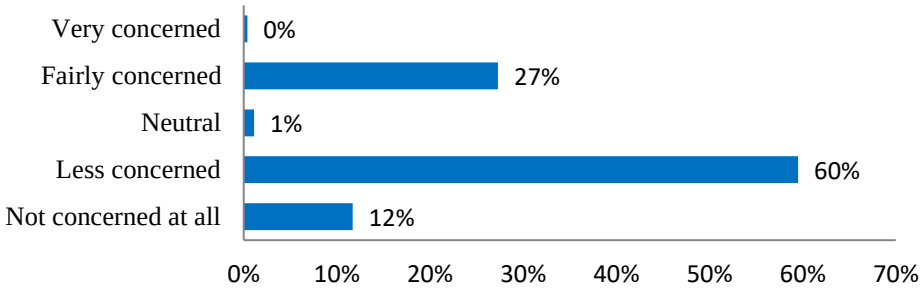
Climate change is a global reality. Its effects are being observed largely in every part of the world. Poor socio-economic conditions, geographical traits, and weather trends of some localities make them more vulnerable to climate change impacts. In this research study, small-scale farmers were inquired about their perception if they have observed climate changes and their impacts at the local level over the last 30 years.

Statistics from field survey reflect that a high majority of farming households (94% in Pishin and 92% in Mastung) reported change in climate at the local level based on their observations over the last three decades.

4.7 Level of Concern about Climate Change Impacts

Understanding and perception affect how much farming community is concerned about climate change and its impacts. The more a community is concerned about climate change and its impacts, the improved the resilience and adaptations will be. Statistics from the field survey reveal (Figure 2) that only 27% of small-scale farmers were worried about climate change at the local level. The majority of respondents (60%) were less concerned while 12% reported that they were not concerned about climate change at all. Such farmers largely believe that climate change is the result of natural factors, human sins, fate and the displeasure of Allah (God). Consequently, people with such perceptions are less likely willing to take mitigation and preparatory measures for future risks (Haque et al, 2022; Qasim et al, 2016; Ainuddin & Routray, 2012).

Figure 2 *Farmers' Level of Concern about Climate Change and its Impacts at Local Level*



Source: Field survey,

4.8 Significance of Personal Behavior and Contribution to Cope with Climate Change

Though climate change is a global phenomenon, behavior of each individual is significant to respond to climate change and cope with its adverse impacts. To gauge the perception of small-scale farmers about the significance of their self-contribution, they were asked to show their agreement level about their behavior and their personal contribution to deal with climate change impacts. A high majority of farming community (67.7%) believe that their personal behavior is not important to respond to climate change while only 18.3 % of farmers think that that personal behavior towards climate change is significant for preparedness, mitigation and prevention. Only 6 percent of household heads perceive that they can make a contribution to cope with the impacts of climate change while a high majority (91 percent in cumulative) expressed disagreement with the statement that they can have any kind of contribution to cope with climate change impacts. The main forces behind such perceptions are their strong attachment to conventional thinking, religious perceptions and poor understanding of modern scientific knowledge of climate change.

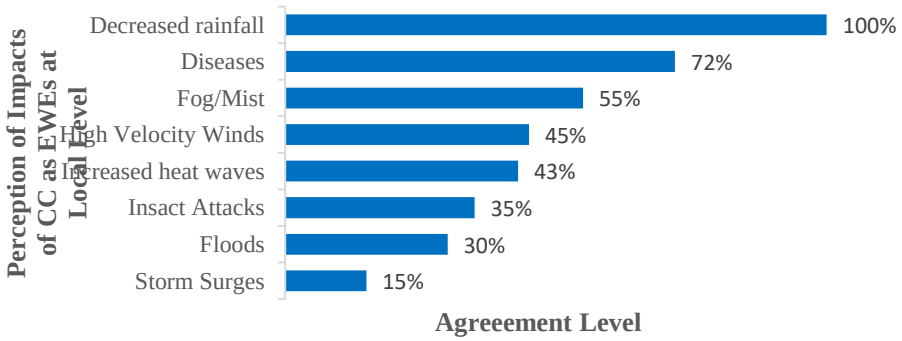
4.9 Impacts of Climate Change at Local Level

Climate change affects the overall socio-economic and environmental conditions. Extreme weather events, disasters and disease outbreaks are more common impacts of climate change at the local level. Perception of small-scale farmers regarding observed impacts of climate change (as

extreme weather events) at the local level was investigated during the field survey. Based on their experience, farmers were asked to show their perception of different extreme weather events as recurrent and intensive impacts of climate change based on their experience at the local level during the last 30 years.

A decrease in rainfall (100%) is the most common and significant observation of farmers as climate change impacts followed by diseases among humans (72%), fog/mist (55%), high-velocity winds (45%), increase in temperature/heat waves (43%). Fog/mist and high-velocity winds affect agricultural productivity and increase management costs. An increase in temperature makes it difficult to manage water for farms thus affecting productivity. Insect attacks (35%) though not common, in the last few years, this outbreak has affected the farming community. Not many farmers perceive this as the impact of climate change. Floods are not recurrent and intensive in the study area (Pishin Lora Basin). Only 30 per cent of farmers believe that floods are potential impacts of climate change. There were extreme floods in most parts of the country including the study area of this study (PLB) in August 2022 which resulted in heavy losses to humans, agriculture, physical infrastructure and the environment. Storm surges (only 15%) are not perceived by farmers as the impacts of climate change in the study area.

Figure 4 *Farmers' Perception of Observed Impacts of CC at Local Level*



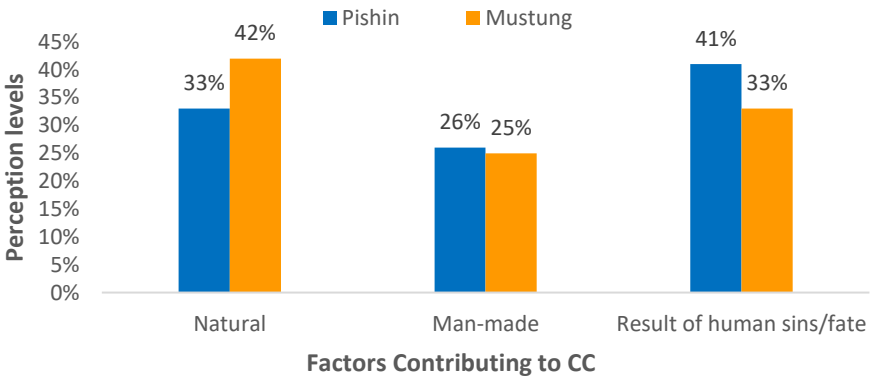
Source: Field survey

4.10 Perception of Climate Change Factors

Local farmers have their own understanding of climate change and the factors that contribute to climate change events. Much of the understanding

and perception of farmers is developed on the basis of local knowledge, access to sources of information, exposure and communication. Farmers' understanding of climate change is strongly associated with their level of resilience and adaptations. Statistics from the field survey (Figure 4) reflect that a notable number of respondents (41% in Pishin and 33% in Mastung) perceive climate change as a result of human sins and their fate. Such farmers believe that climatic events and disasters occur because humans have been engaged in acts that cause displeasure of Allah. People with such perceptions are less likely to take proper measures for climate adaptation. Similarly, another slot of farmers (33% in Pishin and 42% in Mastung) perceives that climate change is a natural phenomenon and that humans have nothing to do with it. These kinds of farmers also tend to be less prepared for climate change events. Almost a quarter of respondents in the field survey (almost 25% in both districts) perceive that humans have much to do with changing climate of the globe and its reverse impacts. This kind of farmers stress mitigation measures, prepare for future risks and are willing to opt for climate change adaptations.

Figure 4 *Farmers' Perception of Major Factors that Contribute to Climate Change*



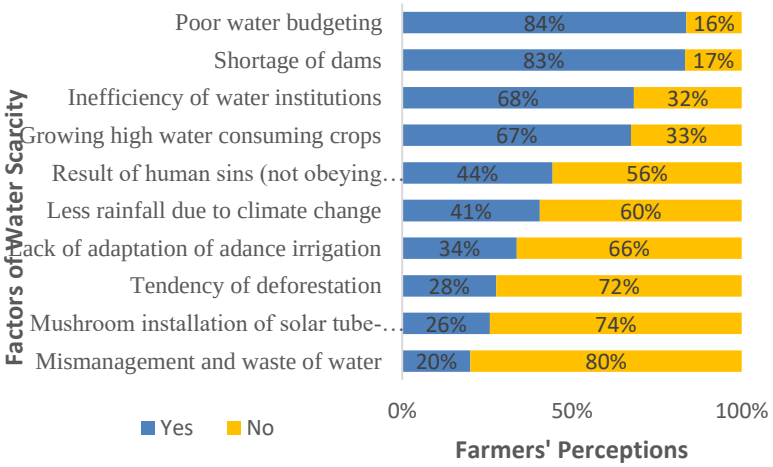
Source: Field survey

4.11 Causative Factors of Water Scarcity

Over the last three decades, water crises in the catchment area of PLB increasingly affected the life of the populous in general and the farming

community in particular. Farmers perceive a number of natural and man-made factors as responsible for water scarcity in the region. Figure 5 is the analysis of farmers' perception of the causative factors of water crises in a sequence from the most responsible factor to the least responsible.

***Figure 5** Factors Responsible for Water Scarcity in the Area*



Source: Field Survey, 2021

Farmers were asked to record their opinion against each variable in terms of their agreement (No or Yes). It was reported that a large number of farmers believed that poor water budgeting (84%) and shortage of dams (83%) are the most responsible factors for water scarcity. Farmers also perceived that the inefficiency of water institutions (68%) and growing high delta/water consuming corps (67%) are responsible for water shortage in the region. 44 percent of farmers believed that water scarcity is the result of human sins and not obeying the orders of Allah. They believe that instead of working on worldly technology for water management, humans need to focus on their acts and obey the orders of Allah. Such farmers have a high attachment to religion and the past.

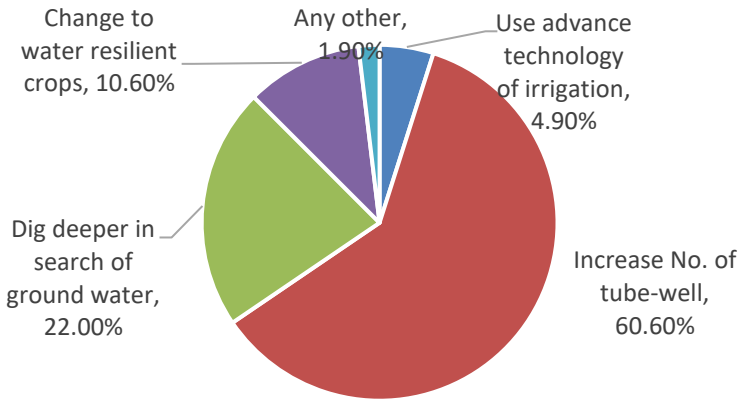
Famers also make climate change responsible for less rainfall (41%). Lesser number of farmers believe that human activities such as lack of adaptations (34%), deforestation (28%), mushroom installation of solar tube wells (26%), and water mismanagement/ waste (20%) are factors of water scarcity in the catchment area of Pishin Lora Basin-river.

The data reflect three levels of farmers' understanding regarding factors of water scarcity. Firstly and largely, they believe that state and institutions are highly responsible for the current situation of water. Thus, they stress government measures to cope with water scarcity. Secondly, they believe that nature and human sins by not obeying Allah are factors of water scarcity. Farmers with this understanding focus on religious measures such as regular worshipping to please Allah which will eventually result in regular rainfall. Farmers with such perceptions are less likely to take measures for adaptions. Thirdly and lesser number of farmers believe that community people are responsible for water scarcity in terms of unwillingness to adaptations, deforestation, mushroom installation of tube wells and water mismanagement. Such farmers, though fewer in number, believe that community members and farmers need to contribute to sustainable solutions to water scarcity and climate change impacts.

4.12 Strategy to Manage Water for Farms during Water Crises

Water scarcity has become a common phenomenon in PLB due to which the vulnerability of small-scale farmers has increased. To cope with such worse conditions, farmers adopt alternate strategies to manage water for farming. During the field survey (Figure 6), it was found that almost 61 percent of small-scale farmers increase the number of tube wells to manage water, and 22 percent dig deeper in search of water. Both alternatives are temporary and not sustainable solutions in the context of climate change impacts in the area. However, almost 11 percent of farmers changed to water-resilient crops and almost 5 percent adopted advanced technology of irrigation to save produce better yields with less water. The later both strategies are climate-friendly and sustainable solutions to water scarcity and climate change impacts.

Figure 6 *Farmers' Strategy to Manage Water for Farms during Water Shortage*



Source: Field Survey

4.13 Perception of Prediction about EWEs

Based on indigenous or/and modern scientific knowledge, farmers may have the capacity to forecast extreme weather events in future. The ability to predict enhances farmers' preparation for extreme weather events which will decrease the risk of socio-economic losses to farming communities. Statistics of the field survey reveal that more than half of respondents in both selected districts (58% in Mastung and 56% in Pishin) believed that they cannot forecast future extreme weather events such as droughts, floods, heat waves etc. 22% farmers reported that they could forecast to some extent. Only 22% of farmers believed that they had the ability to predict the future risk of EWEs. Farmers who had the ability to prediction of future climate trends relied upon past experiences, indigenous knowledge, and scientific knowledge shared on social media, TV, etc. Predictions by senior and experienced community people also assist to a larger extent.

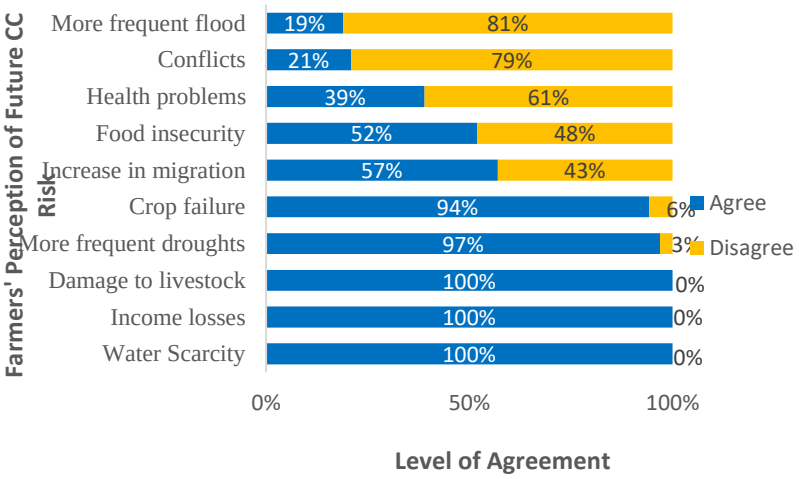
4.14 Perception of Future Climate Risks

Though a high majority of farmers in this study perceived climate change as a result of natural forces, the displeasure of God and human fate (Figure 7), it is pivotal to know their understanding of future risks of climate change events at the local level.

It was found that 79 per cent small-scale farmers perceive that the effects of climate change will get worse in future at the local level. While 21 percent of respondents expressed that they were uncertain about future trends of any event of climate change.

A high majority of small-scale farmers (79%) perceive that risks of different types are associated with smallholder farmers as a result of climate change impacts which will put their life in a challenge. Farmers were further inquired about their perception regarding the type of risks associated with climate change. It was found that all small-scale farmers believed that water scarcity, income losses and damage to livestock, more frequent droughts (97%), and crop failure (94%) are strongly expected to occur in future due to climatic changes. Farmers also perceive that due to climate change impacts, there is a risk of an increase in migration (57%) and insecurity of food (52%). 39 percent of farmers were of opinion that health issues are like to increase due to climate change impacts and extreme weather events. Conflicts are less likely expected to increase in future as perceived by the farming community. Based on previous experiences, farmers expected lesser occurrence of floods in future. A high majority of farmers (81%) disagree with the risk of floods in future in the study area, although, heavy floods hit the province including the Pishin Lora Basin in the month of August 2022. The risk of such floods was never expected by farmers. Due to recurrent drought spells during the last three decades, farmers' perception was built that climate change will result in water scarcity, intensive drought, income loss and food insecurity.

Figure 7 *Farmers' Perception of Future Climate Change Risks (N=209)*

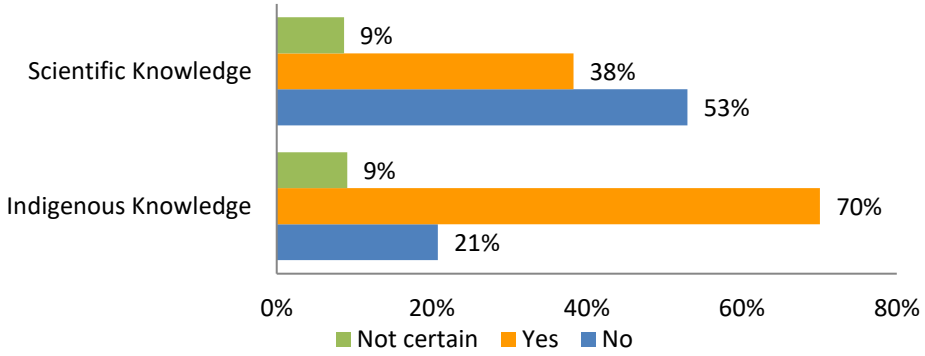


Source: Field survey

4.15 Perception of Indigenous and Scientific Knowledge

Indigenous knowledge is an asset for dealing with events of climate change and their impacts. Whether small-scale farmers find it useful to make use of indigenous knowledge in dealing with climatic hazards, farmers were inquired about their perceptions. As elaborated in figure 8, a good majority of household heads (70%) perceived that they find indigenous knowledge and local experience local useful in dealing with climatic hazards while 21 % of farmers did not agree with the perception. 9% of farmers were not certain about the usefulness of indigenous knowledge. Traditional knowledge affects the way local people perceive and cope with environmental and biophysical challenges (Pearce et al., 2015). It also explains the way people react to programs and policies that are either in line with their understanding or otherwise. Strengthening of adaptation and resilience is not merely dependent on advanced technology and research but it is also very important to enhance the ability of vulnerable communities to deal with climatic stressors through local knowledge and behavioral changes for improved livelihood (Yamba et al., 2019; Ayeb-Karlsson et al., 2016).

Figure 8 *Perception of Indigenous and Scientific Knowledge to Deal with Climatic Hazards*



Source: Field survey

Scientific knowledge is also pivotal for farmers to cope with climatic hazards and their impacts. However, more than half of community members (53%) perceived that scientific knowledge is not effective in dealing with climatic hazards in the context of local conditions. 38 percent of smallholder farmers find it effective to use scientific knowledge to cope with climate change, climatic hazards and the potential impacts. Only 9% were not certain about the effectiveness of scientific knowledge (Figure 8). Farmers with scientific knowledge are more willing to adopt modern technology of irrigation, farming and climate-smart methods. They take effective measures for adaptations and are more resilient in disastrous conditions.

4.16 Results of Correlation Coefficient of Study Variables

Table 2

Nonparametric Correlations of Study Variables (Spearmen's Correlation) (n = 264)

	Variables	*1*	*2*
.	*Education Level*	-	
.	*Religious belief of CC*	*13**	—
.	*Awareness of CC*	*08*	*. 0.06*

Level of concerned about CC	*23***	*.21***	*14**	—
Personal contribution to mitigate CC	*0.02*	*.05*	*.00*	*51****
Ability to forecast EWEs	*29****	*0.12*	*.15**	*26****

**p<.05. **p<.01. ***p<.001.*

Table 2 highlights the correlation between variables of farmers' knowledge of climate change and variables of different components of resilience. The data type is categorical, thus Spearmen's correlation test was applied to check the level of relationship between and among variables.

Data reveals that the education level of smallholder farmers has a strong positive association with the level of farmers' concentration on climate change (r = .23, p<.001), farmers' ability to forecast EWEs (r = .29, p<.001); and religious belief about climate change (r = .13, p<.01)

Farmers' religious belief in CC has a strong negative correlation with the level farmers are concerned about CC (r =-.21, p<.001).

The awareness level of farmers regarding CC is positively correlated to farmers' concentration of CC (r = .14, p<.05); and ability to forecast EWEs (r = .15, p<.05).

Farmers' level of concern has a strong positive correlation with farmers' personal contribution to contribute to CC mitigation (r = .51, p<.001); and their ability to forecast EWEs (r = .26, p<.001).

Table 3 *Nonparametric Correlations of Study Variables (Spearmen's Correlation)*

	Variables	1	2	3	4	5	6
1.	*Education level*	—					
2.	*Willingness to adopt modern irrigation techniques*	*.17***	—				
3.	*Ability to forecast EWEs*	*.29****	*.24****	—			
4.	*Social networking*	*.03*	*-.02*	*.05*	—		

5.	*Membership with CSOs*	*-.00*	*.01*	*.01*	*.70****	—	
6.	*Gender balance in domestic decision making*	*.04*	*.00*	*.12**	*.45****	*.53****	—
7.	*Interest in Scientific knowledge of CC and resilience*	*.02*	*-.01*	*.04*	*.14**	*.14**	*.13**

**p<.05. **p<.01. ***p<.001.*

Table 3 reflects the correlation (Spearmen's Correlation) among different dichotomous/categorical variables of the study. Data shows that the education level of farmers has a significant positive correlation with farmers' willingness to adopt advanced irrigation techniques (r=.17, p<.01), and farmers' ability to forecast EWEs (r=.29, p<.001).

Farmers' willingness to adopt advanced irrigation techniques also strong significant positive correlation with farmers' ability to forecast EWEs (r=.24, p<.001) while farmers' ability to forecast EWEs has a weak significant correlation with gender balance in domestic decision-making (r=.21, p<.05).

The variable social networking of farmers has a strong positive association with membership in CSOs (r=.70, p<.001); gender balance in domestic decision-making (r=.45, p<.001)' and farmers' interest in scientific knowledge (r=.14, p<.05).

Farmers' membership with CSOs also has a significant association with gender balance in domestic decision-making (r=.53, p<.001) and farmers' interest in scientific knowledge (r=.14, p<.05).

The variable gender balance in domestic decision-making also has a positive dependency on farmers' interest in scientific knowledge (r=.13, p<.05).

***Conclusion**:*

This research paints a clear picture of the complex human landscape facing climate change in arid northwest Pakistan. Farmers are undeniably

on the front lines, with nearly all witnessing shifts in weather patterns over decades. However, their responses are deeply filtered through a lens of local culture, religion, and lived experience. For many, climate change is seen as an act of God or a natural cycle, leading to a sense of powerlessness and a reliance on faith rather than proactive adaptation. Water scarcity, a daily crisis, is often blamed on government failure and poor infrastructure, pushing farmers toward unsustainable solutions like drilling deeper wells instead of adopting water-saving technologies.

A significant barrier is the lack of accessible, trusted information. With low literacy rates and heavy reliance on informal community networks, scientific knowledge struggles to find a foothold. This creates a divide where valuable indigenous knowledge—such as observing environmental signs—exists but is not effectively partnered with modern, climate-smart agricultural practices. The study reveals that farmers with more education and exposure to scientific ideas show greater concern and a stronger willingness to adopt adaptive measures, pointing to a pathway forward.

Ultimately, the findings call for a more empathetic and integrated approach to climate policy. Top-down technological solutions will fail without understanding and respecting the local beliefs and knowledge systems that shape farmers' worlds. Effective adaptation requires dialogue—blending scientific expertise with indigenous wisdom, improving climate communication through trusted local channels, and designing interventions that farmers perceive as both practical and legitimate. Building resilience in these vulnerable communities depends not just on better water infrastructure, but on bridging the gap between perception and science, empowering farmers to see themselves as active participants in securing their own future.

Acknowledgement:

The present work is based on the doctoral thesis of the principle author i.e. Muhammad Yousuf, Lecturer, Department of Social Work, University of Balochistan, Quetta. We thank the university and the doctoral committee for their academic support.

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