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FARMING COMMUNITIES AUTONOMOUS ADAPTATION TO CLIMATE CHANGE IN PAKISTAN: A REVIEW

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Abstract. Rural farming communities in Pakistan are highly vulnerable to climatic events such as increases in temperature, floods, and droughts. The study synthesizes the autonomous response to climate-related stresses in rural Pakistan. The main purpose of the study is to provide a review of farm households' adaptations to climate change with special reference to key adaptation drivers and factors that impede its process. The study indicates significant adaptation uptake among rural farm households in Pakistan. Main autonomous adaptation strategies include changes in sowing time, crop diversification, and changes in agriculture inputs. However, the adaptation potential in terms of available options as well as the uptake is very low. The main hindrances include households' limited capacity in terms of financial constraints and education, lack of access to climate risk information, e.g., flood warning and farm advisory services, and inadequate supply of basic amenities. Therefore, to enhance the uptake and diverse use of adaptation options in rural communities, the relevant agencies need to focus on the removal of the barriers and the improvement of the key adaptation drivers.

Keywords: Climate change, risk perception, adaptation, farm-households, Pakistan

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I. INTRODUCTION

Climate change has affected various natural and human systems almost all over the world (Dokken 2015; Masson-Delmotte et al. 2018). Globally, natural disasters have shown a sharp rise over time, especially after the 1960s (Figure 1). Pakistan is also seriously exposed and vulnerable to climatic disasters such as floods and droughts (Chaudhry 2017). The country has suffered serious damages, including life losses from natural hazards (Appendix-I).

According to the Global Climate Risk Index 2021 report[1], Pakistan is one of the ten countries most affected by natural hazards during 2000-2019 (Eckstein et al. 2021). The main reason behind Pakistan's vulnerability to disasters is that the economy relies greatly on agriculture (Mumtaz et al. 2019). The agriculture sector employs approximately 42% of the labor force and makes up nearly 21% of labor[2]. Nearly 62 percent of the country's population resides in rural areas and is directly or indirectly linked with agriculture for their livelihood[3]. Research, however, suggests that the vulnerable communities' response to climate adaptations[4] has started emerging slowly (Chaudhury et al. 2016).

Climate adaptation has the potential to offset or exploit the effects of climate change on socio-ecological systems (Blanco et al. 2017) and expand the solution set (Bateman and O'Connor 2016). It is, therefore, a core element and crucial component of climate policy and research (Ford et al. 2014; Ford and King 2015; Ali and Erenstein 2017).

Climate adaptation can considerably lower predicted negative climate impacts (Farnham and Kennedy 2015; Kussel. G. 2018); hence its need is widely recognized for social and natural systems (Wise et al. 2014). Additionally, adaptation has high stakes for future societies (Harrison et al. 2015) and, thus, has a central place in the societal and governmental agendas around the world to respond to and deal with climate impacts (Eakin et al. 2014). Therefore, climate adaptation and

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[1] https://www.germanwatch.org/sites/default/files/Global%20Climate%20Risk%20Index%202021_2.pdf

[2] https://www.pbs.gov.pk/content/agriculture-statistics

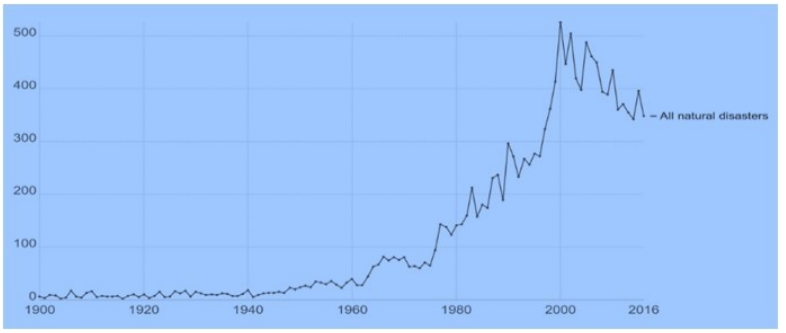
[3] https://www.finance.gov.pk/survey_1718.html

[4] Climate adaptation refers to the process of adjustment to the actual or expected climate and its effects to moderate or avoid harm or exploit beneficial opportunities (IPCC, 2014)

preparedness for extreme weather events are necessary at all scales (Carlson and McCormick, 2015).

FIGURE 1

Total Number of Global Reported Natural Disasters



Source: http://cms.ndma.gov.pk/

Climate adaptation research has progressed significantly in the last decade (Dittrich et al. 2016; Amir et al. 2020), and there is a well-established body of scholarship on climate impacts, adaptive capacity, and adaptation options (Ford and King 2015). However, understanding of the adaptation process, driving factors, magnitude, and behavioral responses is still insufficient (Arnott et al. 2016; Woodruff and Stults 2016). In addition, the implementation and optimal use of adaptation potential remained limited (De Stefano et al. 2017). The adaptation implementation has especially been inadequate in developing countries, despite induced exposure to climatic stresses.

The adaptation to changing climate in agriculture is the adjustments in capital investments, agricultural processes, and agronomic practices in reaction to expected and/or observed threats of changing climate (Shahid et al. 2021). The developing economies greatly rely on agriculture is inherently sensitive and exposed to climatic hazards (Bojovic et al. 2015; Harrison et al. 2015; Khanal et al. 2018). Therefore, there is a need to foster adaptation in developing countries to reduce vulnerability and improve resilience to climatic changes (Vignola et al. 2009). Rural households in developing countries adapt to climate risks and their impacts both individually and collectively (Paul et al. 2016). There are differences in climate impacts as their manifestations are at the local

scale (Regmi et al. 2016). Hence, the adaptive actions should also be local and more context specific (Oberlack and Eisenack 2014; Ingold 2017).

This study reviews the adaptation case studies conducted in relatively similar socioeconomic and cultural settings in rural Pakistan to understand the adaptation process. The case studies were carried out using primary surveys and based on autonomous adaptations. The study aims to investigate the adaptations and draw meaningful conclusions regarding local communities' risk perception, adaptation uptake, driving factors, and adaptation barriers. The discussion will inform policymakers in designing context-specific strategies to promote rural autonomous adaptations and thus contribute to the adaptation progress in Pakistan. The review was performed between the years 2020-2021. We identified keywords for the search process and based on previous studies, the keywords "case studies on autonomous adaptation practices among the farming community in Pakistan" were used. The review was carried out using relied on robust journal databases – Science Direct and Google Scholar. After the screening, the review resulted in a total of 45 articles that were used for the analysis.

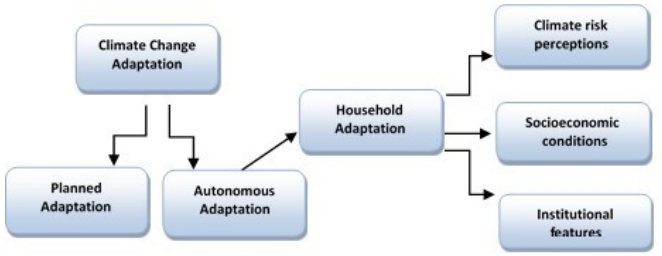
This study is vital, in view of the potential and significant effects of climate change on agriculture and food security, combined with the increasing population in Pakistan (Khan et al. 2020). That calls for urgent adaptation actions to enhance resilience in the agriculture sector. Despite the abundance of studies on farmers' climate change adaptation, efforts to review the adoption of autonomous adaptation strategies and their drivers are still lacking in Pakistan. This paper fills an important gap in the literature, with a systematic review examining autonomous adaptation efforts among farmers of Pakistan. Therefore, it provides details on where the peer review literature has so far focused and the opportunity to understand where the emphasis is and where attention needs to be placed. A special focus was given to Pakistani farmers as this group is most affected by the changing climate due to their higher reliance on nature stability for conducting their socioeconomic practices.

ADAPTION FRAMEWORK

Adaptation to climate change is critical for Pakistan, which is one of the most vulnerable countries[5]. The heavy reliance on agriculture coupled with poor socioeconomic resilience forces Pakistani rural farm households to adapt to climatic changes. Adaptations are of an autonomous nature that reduces the communities' exposure and develops their resilience to climate stresses. The reviewed case studies show that three sets of driving factors, climate risk perceptions, socioeconomic conditions, and institutional features, explain the autonomous adaptation uptake in rural Pakistan. These factors play the determinants' role, thereby either supporting or impeding the adaptation process.

FIGURE 2

Autonomous Adaptation Framework



Source: Author's own

Climate risk perceptions are the function of past climate hazards experience, exposure, climate information, and the climate hazards' frequency and intensity. Socioeconomic conditions encompass the households' social, economic, and demographic characteristics such as income, education, employment, landholding, etc. At the same time, institutional factors involve the generation and dissemination of climate information, disaster mitigation actions, and other material and non-material support from relevant agencies and departments, such as advisory services of agricultural extension.

The following sub-sections present the discussion on the adaptation drivers using the reviewed case studies.

[5] https://cdkn.org/regions/pakistan-asia

CLIMATE RISK PERCEPTIONS

Climate risk perception is a primary determinant of adaptation (Frondel et al. 2017; Lee and Hughes 2017; Nazir et al. 2018). Understanding the risk perceptions of the communities exposed to climatic hazards helps to examine the adaptation practices (Li et al. 2017). There are a few case studies that have investigated farm households' climate risk perception in Pakistan. The overall impression is that the farm households and communities, in general, understand the climate risk and are risk-averse in nature (Rana and Routray 2016; Saqib et al. 2016; Ahmad et al. 2020). For example, Abid et al. (2016) showed that almost 80% of farmers in the study sample, picked in Punjab, perceived climate change.

In Punjab, maize farmers perceive biological and price risks (Akhtar et al. 2019), whereas rice farmers face multifarious risks, including environmental and production risks like water shortage, increased temperature, flooding, heavy rainfall/hailing, high input prices, and crop disease (Ahmad et al. 2020; Rizwan et al. 2020). Meanwhile, Khan et al. (2020) demonstrated that biological and financial risks were the high risks perceived by rice farmers, followed by biophysical, climate, and social risks in the rice-growing region of Pakistan.

In Sindh, insufficient agriculture equipment is identified as the major risk source, followed by human health issues, crop diseases, lack of research, and uncertainty in agriculture productivity (Nazir et al. 2018). Also, most of the farmers in rain-fed parts of Punjab recognize that climate-related events pose severe threats to human health, crops, and livestock production, hence compromising farmers' livelihoods (Amir et al. 2020). Abid et al. (2017) revealed that farmers have a strong perception of a decrease in crop production and an increase in crop disease and pests due to climate change in the agroecological zones of Pakistan.

Meanwhile, Khan et al. (2020) came up with an interesting finding by identifying a difference in the perception of climate-related risks across the KPK province of Pakistan. For instance, farmers in District Swat and Dir consider decreased soil fertility, forest degradation, and water quality deterioration as main climate risks. Whereas farmers in Malakand, Mardan, and Peshawar consider droughts, pests, and diseases

as the main climate risks. Similarly, Wahid et al. (2018) mentioned that Farmers perceive numerous risks like disastrous floods, droughts, changes in rainfall patterns, and loss of farmland due to floods, are negatively affecting agricultural production Charsada District of KPK.

Socioeconomic and climatic factors such as farm specifications, market features, and past flood experiences influence the households' risk perception and attitude (Qasim et al. 2015; Saqib et al. 2016; Ullah et al. 2016; Nazir et al. 2018; Rizwan et al. 2020); Saqib et al. 2016). Moreover, education, gender, religion, age, credit access, off-farm income, livestock, and experience of farming significantly influence farmer risk perception (Nazir et al., 2018; Ahmad, Afzal et al., 2020). Also, the availability of advisory access and credit utilization are among the significant determinants of farmers' risk perceptions and attitudes (Khan et al. 2020).

Communities' risk perception and risk aversion behaviour play a major role in adaptation decisions (Saqib et al. 2016; Akhtar et al. 2019). Nevertheless, farmers are less likely to take up adaptation activities and investments due to the risk of failure (Ullah et al. 2016). Also, certain degrees of disagreement exist between the sources of risk sources and coping strategies, mainly due to the lack of adequate capital and education (Nazir et al., 2018).

Meanwhile, Abid et al. (2019) demonstrated that climate change knowledge and risk perception determine Farmers' ability and willingness to adapt agricultural systems. Yet, Ullah et al. (2019) found that rural farmers fail to adapt timely and effectively due to technological and financial barriers they face despite having sufficient knowledge of climate change knowledge and higher risk perception.

Moreover, Rana and Routray (2016), identify a gap between actual and perceived risks in flood-prone areas, and the lack of access to formal sources of risk information adds to the risk perception. For example, farmers have valid perceptions of increasing mean temperature, but there is a discrepancy between local climate records and farmer perceptions of rainfall changes in three agroecological zones of Punjab (Abid et al. 2019).

Few studies, however, found a positive correlation between actual and perceived risk and claim that the perceived risk increases with the increase in actual risk (Qasim et al. 2015; Rana and Routray 2016). Moreover, Qasim et al. (2015) observed that risk perception varies across government and communities and attributed it to the lack of risk awareness among the communities. The possible reason is that the disaster management policies in Pakistan have not incorporated the communities' risk perceptions.

The above-cited literature on climate risk perception indicates that the exposed communities seem to be cognizant of the climate risk; nevertheless, they are not fully aware of its level and intensity. Thus, they are unaware of a disaster's potential for possible damages. This shows that disaster management in Pakistan lacks the effective dissemination of disaster risk information. This creates a knowledge gap that precludes the communities from precisely assessing and responding to climate risks. This becomes more complex in rural and remote areas with complex socio-cultural settings. Therefore, there is a need to ensure the adoption of a participatory disaster management approach for inclusive and holistic disaster management planning.

SOCIOECONOMIC CONDITIONS

Socioeconomic conditions can either support or hamper the adaptation uptake among farm households in rural communities. The main socioeconomic factors that influence adaptation decisions in the study areas include but are not limited to household head age, education, income, gender, household size, house ownership, access to credit, and wealth (Abbas et al., 2015; Ali 2017; Ali and Erenstein 2017; Ullah et al. 2017; Gorst et al. 2018; Nazir et al. 2018; Akhtar, Maann et al. 2019; Akhtar et al. 2019; Bakhsh and Kamran 2019; Amir et al. 2020; Khan et al. 2020).

In addition, the adaptation uptake is also influenced by farm-specific characteristics, as the case studies are conducted with rural farming households. The key farmer-specific factors that affect adaptation include farm location, landholding size, land rights, farming experience, tube wells' ownership, farmers' connection, livestock ownership, marketing information, and access to agricultural extension as well as geographical

zones (Ashraf et al. 2014; Abid et al. 2016; Ali 2017; Abid et al. 2019; Bakhsh and Kamran 2019; Abbasi and Nawaz 2020; Amir et al. 2020; Khan et al. 2020).

Moreover, Ahmad et al. (2021) identified that for female farmers, schooling years and access to agricultural land were highly significant factors as compared with male farmers for adaptation to floods. Also, Khan et al. (2020) revealed that perceptions of local weather change (temperature and rainfall) had a significant influence on the selection of adaptation strategies along with other factors. Bakhsh and Kamran (2019) indicated that family size and tractor ownership are also significantly related to adaptation to climate change.

INSTITUTIONAL FEATURES

Institutional features comprise a variety of things ranging from disaster governance and adaptation implementation to the provision of basic amenities such as health, education, and road infrastructure. Institutional features that influence the adaptation uptake in the Pakistani context are those that have been reported by the reviewed case studies. For example, the provision of climate information, access to credit sources, effective delivery of agricultural extension services, and external support contribute to the adoption of adaptation (Ashraf et al. 2014; Saqib et al. 2016; Ullah et al. 2017; Gorst et al. 2018).

Particularly, Abid, Ngaruiya et al. (2017) examined farm-level institutional support in three agro-ecological zones of Punjab and reported that extension services are key institutions in the climate adaptation network, while agricultural credits, post-harvest services, and marketing were also dominant. Further, farmers adapt more and opt for advanced adaptation measures rather than low costs and short-term measures, with an increase in the provision of services.

Farmers in the Charsada District of KPK reported that lack of access to financial services, information, and agricultural training and lack of support from the governments were among the major constraints to the adaptation (Wahid et al. 2018). Abbasi and Nawaz (2020) found that farmer's awareness has a positive association with the adoption of

adaptation to climate change whereas a negative association with climate change adaptation-related problems.

The diverse determinants of adaptation decisions require comprehensive adaptation planning that incorporates all the key aspects of adaptation decisions. For instance, sustainable livelihood, basic amenities, and agriculture extension services largely define adaptive behaviour. Furthermore, given the fact that climate change has multi-dimensional impacts, the involvement of all primary stakeholders is critical for holistic, inclusive, and integrated adaptation planning.

II. HOUSEHOLD ADAPTATIONS

This section discusses the households' adaptation in rural communities of Pakistan. The assessment of adaptations and their impacts is complicated due to the inherent uncertainty (Mechler and Kundzewicz 2010) and insufficient information about their effectiveness. Understanding adaptation in developing countries is more intricate due to the complex socioeconomic conditions, limited knowledge of climatic changes, and fragile institutions (Klostermann et al. 2018).

The present study reviews the adaptation case studies in rural parts of Pakistan to consolidate the progress of adaptation research in Pakistan. The analysis reveals some useful insights regarding adaptation behaviour that help draw meaningful conclusions. Such exploration and assessment of adaptations can help make progress in adaptation research and augment the implementation efforts.

The research shows that the overall farm-level adaptation strategies are more or less similar across the different regions of Pakistan. For example, most of the farmers in Punjab use changes in planting dates, crop varieties, and crop switching, agricultural inputs like fertilizers and pesticides, adoption of soil or water conservation, and income diversification as adaptations (Abid et al. 2015; Ali and Erenstein 2017; Gorst et al. 2018). However, Akhtar et al. (2019) reported that increased irrigation and integrated farming were the main strategies for minimizing the climate change impact on crop production in the rice-wheat cropping zone in Punjab. Similarly, Siddiqua et al. (2019) found that change in irrigation practice gave the highest wheat yield among all other

adaptation strategies like change in the time of sowing and varieties and use of inorganic fertilizer.

Fahad and Wang (2018) and Wahid, Takaaki et al. (2018) reported that changing crops type and cultivation patterns, planting shaded trees, improving seed varieties, and the provision of excessive fertilizers as the main adaptation strategies in response to soil fertility loss, water scarcity, changes in crop yields and crop diseases in KPK Province of Pakistan. Ali (2017) reported similar strategies such as sowing time adjustment, adoption of resistant varieties, tree plantation, non-farm participation as well as crop-livestock interaction from the Himalayan region of Pakistan. Likewise, Ashraf et al. (2014) show that farmers in Baluchistan use crop management, water management, an adjustment in agricultural inputs, income diversification, economization of expenditure and consumption smoothing, migration, assets selling, and borrowing to adjust to the drought impacts in the region.

The research suggests that adapting agriculture to climate change has significant positive benefits for farmers in terms of crop yield (Abid et al. 2015; Ali and Erenstein 2017; Gorst et al. 2018; Akhtar et al. 2019; Siddiqua et al. 2019). In addition, the on-farm adaptation implementation has sufficient potential to enhance local food security and offset the climate impacts on agriculture (Abid et al. 2015; Ali and Erenstein 2017; Gorst et al. 2018).

An interesting observation is that farm households prefer well-known, easy, and short-run adaptation measures to be unfamiliar, complex, and long-term options (Shah et al. 2017). This indicates that the farmers are less likely to adopt technologies that are complex and yield benefits in the long run. Also, Ullah et al. (2019) found out that poor rural farmers usually tend to adopt measures that are economical instead of environmentally feasible measures. Akhtar, Li et al. (2019) observed a strong correlation between the two adaptation strategies: off-farm diversification and agricultural credit, in response to climate risks to maize production in Punjab. Whereas Ahmad et al. (2021) came up finding that gender difference plays an important role in adopting different flood adaptation strategies. For example, Females are more likely to adopt diversified income sources like rearing livestock, whereas males prefer sharecropping status in Southern Punjab.

Abid, Scheffran et al. (2019), however, found a strong correlation among the three adaptation stages (perceptions, intentions, and adaptation) and further found that farmers prefer basic-level adaptation measures, including changing crop varieties, input use and planting dates over advanced measures, such as soil conservation, and planting shade trees. Similarly, Khan et al. (2020) found that perception of climate risk and farmer attitude influence farm-level productivity, investment, and management decisions and revealed that mulching and farm insurance were the main adaptation strategies.

Livelihoods in rural semi-arid regions of Pakistan are highly exposed to climate change impacts such as erratic rainfalls, temperature rise, and more frequent as well as intense climate-related extreme events. This phenomenon is posing new risks to the already marginalized communities that have high poverty rates (Qaisrani et al. 2018). Ali and Erenstein (2017) found that Farm households in arid regions of Punjab mainly use private adaptation measures at the individual level, which mainly include manure application, deep ploughing, bund-making, income diversification, crop diversification, and land renting-out. However, the benefits of private adaptation can be private and public depending on the type of adaptation strategies. Amir et al. (2020) confirms reliance on several adaptation strategies ranging from changes in planting dates to compromises over the education of children in response to climate change-related stress in the rain-fed region of district Chakwal, Punjab.

Few studies have touched on the theme of poverty and climate change and offer useful insights. For instance, research shows that subsistence farmers are relatively more vulnerable and have a higher risk perception (Saqib et al. 2016; Ali and Erenstein 2017). The results from Ashraf et al. (2014) study is pertinent in this regard, where the authors found that the poorer households use economization of expenditure, consumption smoothing, and assets selling to adapt. Likewise, the proportionate losses of fruit production and livestock from drought are higher among poorer farmers. However, the households that have adapted faced lower poverty hence indicating scope for policy to further promote the adoption of climate change adaptation strategies (Ali 2017; Ali and Erenstein 2017).

Abid et al. (2015) found that households with large farm sizes in Punjab adapt relatively more. This may be due to the higher risk associated with large farm sizes in addition to the availability of the resources that enable them to adapt better. This implies that poverty precludes poor households from an adaptation that has a bearing on the households' affordability and adaptation cost. Nevertheless, adaptation is vital and critical for poor households to avoid further damage. Therefore, some support or safety nets for the vulnerable segments may help them adapt to changing climate.

TABLE 1

Summary of the Main Reported Adaptations

Studies	Adaptation options
(Ashraf et al. 2014)	Crop management, water management, an adjustment in agricultural inputs, income diversification, economization of expenditure and consumption smoothing, migration, assets selling, and borrowing
(Saqib et al. 2016) & (Ullah et al. 2016)	Agriculture credit
(Mustafa et al. 2017) & (Ullah et al. 2018)	Changing crop variety and planting dates, tree plantation, conserve irrigation water.
(Shah et al. 2017)	Elevated ground floor, foundation strengthening, construction of house with reinforced material and precautionary savings
(Nazir et al., 2018)	Crop insurance, off-farm income sources, market information, and production diversity.
(Akhtar et al. 2019)	Livestock and crop insurance, land-leveling, tree plantation, and bund-making
(Rehman et al. 2019)	Selling of household assets, low food consumption, alternate income sources, migration from the drought-prone region.
(Ullah et al., 2019), (Abid et al. 2019) &(Mustafa et al. 2017)	Changing fertilizer and crop variety, planting shade trees, soil conservation measures, and conserve irrigation water.
(Akhtar et al. 2019)	Growing recommended crop varieties, increased use of pesticides and irrigation
(Ahmad et al. 2021)	Change in cropping patterns and varieties, improved irrigation methods, sharecropping, alternate sources of household income,
(Amir et al. 2020)	Changes in planting dates and compromise on children's education
(Khan et al. 2020) & (Mahmood et al., 2020)	Crop diversification, alteration in the crop calendar, change in fertilizer, mulching and farm insurance,

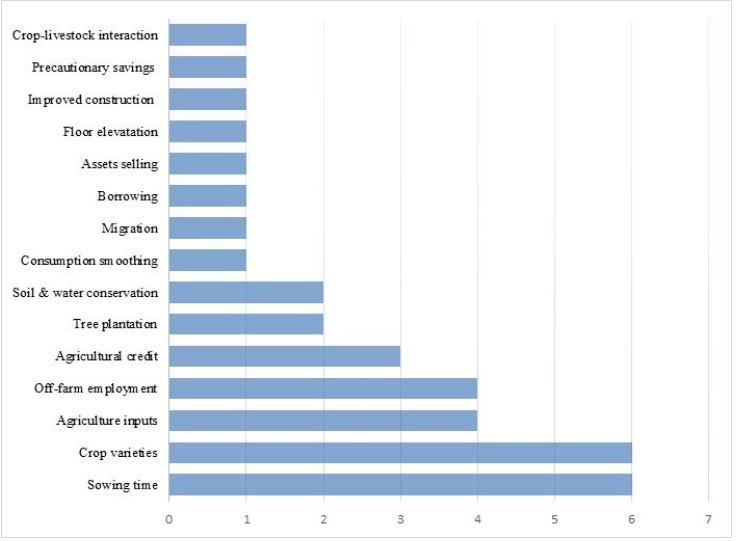
Source: Author's own

The use of climate finance options to manage climate risk in rural areas of Pakistan is insignificant. Wahid et al. (2018) observed that small farmers hardly use precautionary savings and agriculture credit to

manage climate risk and have lower access to related information and resources. Even the subsistence farmers that use agriculture credit as a risk management strategy have very limited access to credit sources (e Saqib et al. 2016). Abbas et al. (2015) claim that rural farm households have limited financial capacity to purchase flood insurance. This indicates the limitations to the use of financial products for climate change adaptation in rural areas of Pakistan, despite the communities' readiness.

FIGURE 3

Frequency of Main Reported Adaptations



Source: Author's own

Farmers simultaneously use different risk management strategies that, in some cases, are connected. Wahid et al. (2018) state that adopting one risk management tool may induce farmers to adopt the other at the same time. Additionally, the use of combinations of different adaptation measures was found to be more useful compared to the adoption of the single adaptation strategies (Abid et al. 2016). This is possibly due to the adopters' recognition of adaptation incentives as well as the possible synergies of the combined use of adaptations. This implies that the diversification of the adaptation portfolio is necessary to optimize the adaptation potential.

The frequency of reported adaptations reveals that three types of adaptations, agriculture, house construction, and household economic management, are more common in study areas. Yet, agriculture-related adaptations are more frequent.

For example, changes in the sowing season, crop varieties, off-farm employment, agriculture credit, tree plantation, water and soil conservation, and agriculture inputs are the recurring adaptation options. The rest of the adaptations have almost the same tendency of adoption.

EFFECTIVENESS OF HOUSEHOLD ADAPTATIONS

Despite a limited understanding of adaptations and a lack of sufficient institutional support in rural areas, communities have adapted. This suggests that they recognize the benefits involved in adaptation and thus use them to reduce their exposure to climate risk. The following are some of the key factors that are responsible for the effectiveness of autonomous adaptations in rural areas of Pakistan.

SCALE

The review of the adaptation case studies shows that the communities respond to natural hazards at different scales. This yields desirable outcomes within their socioeconomic and personal constraints. This can create an impact without having serious social or financial implications. Thus, one of the determinants of the success of autonomous adaptations in rural areas is the choice of the right scale of adaptation. This can help in maximizing the returns on tangible as well as non-tangible adaptation investments.

CONTEXT

The mixed-use of adaptation options with varied uptake indicates adaptation context. Experts often do not spend sufficient time understanding the local context, such as climate, geography, local livelihood, and cultural conditions. This impedes adaptation uptake, and even good policies do not yield desirable results. For instance, people who rely on livestock may find it difficult to switch a particular fodder crop. Hence, the adaptation strategies must consider the local conditions.

In this regard, the present analysis suggests a detailed scoping of the adaptation programs.

APPROACH

This study gives the impression that the most effective adaptation measures are those immersed with existing practices, customs, and belief systems. Therefore, it is extremely important to design interventions that are in line with indigenous knowledge and practices. For instance, given the low education and literacy, adopting new strategies and technologies has lower chances of success. The best approach is to alter and upgrade the existing practices that will be successful in creating the impacts.

KEY ADAPTATION BARRIERS

The reviewed case studies have identified certain adaptation barriers that deter adaptation implementation in the Pakistani context. There is evidence of a poor understanding of the role of institutions and, thus, their contribution to the adaptation process (Gorst et al. 2015). This means that there is a general lack of awareness among rural households about the role of different agencies and the ways those agencies can help them adapt to climatic changes. Additionally, studies indicate that the farmers' connection to extension services, use of social capital, and adoption of improved irrigation technologies were found to be sub-optimal (Ashraf and Routray, 2013; Ashraf et al., 2014).

Research shows that small farmers' poor access to agriculture credit and the absence of an agricultural credit policy negatively affect the adaptation process (Saqib et al. 2016; Ullah et al. 2017). Furthermore, farmers' land rights, e.g. tenancy versus ownership, also undermine the adoption of adaptation measures in some cases (Rahut & Ali, 2017). In addition, financial constraints, timely access to climate information systems, and inadequate resource allocation also hinder the adaptation process (Ashraf and Routray, 2013; Abid et al., 2016; Shah et al., 2017).

PROPOSED ADAPTATIONS

There is a range of adaptation options that can be effective in enabling rural and farm communities to adapt to climatic changes in Pakistan. However, not all of them are in practice as communities are

either not aware of those options or they do not know about their scope and success in a local context. The reviewed case studies pointed out several adaptation options regarding the construction, agriculture, information systems, and livelihood of farm households among vulnerable communities. The case studies suggested that these adaptations are viable in specific contexts. In addition, there is evidence of their use in closely similar settings.

TABLE 2

Main Proposed Adaptations

Studies	Adaptations
(Abbas et al. 2015)	Crop and flood insurance
(Ashraf and Routray 2013; Ashraf et al. 2014)	Improved irrigation water efficiency
(Ashraf et al. 2014; Ahmad et al. 2016; Ullah, Shivakoti et al. 2017; Ahmad et al. 2020)	Use of agriculture credit
(Ashraf et al. 2014)	Growing farmer's social capital and information.
(Ashraf and Routray, 2013)	Adoption of rainwater harvesting
(Abid et al. 2017)	Climate-smart crop varieties
(Shah et al. 2017)	Resilient building infrastructure, i.e. building codes
(Ali and Erenstein 2017)	Alternative livelihood
(Nazir et al., 2018)	Establishing/activating the farm advisories
(Akhtar et al. 2019)	Engagement of community-based organizations and participatory approaches.
(Ullah et al., 2019) & (Abid et al. 2019)	Climate-related information among farmers
(Mustafa et al. 2017)	Price incentives and improving education level and awareness.
(Amir et al. 2020)	Integrated efforts towards technical, financial, and institutional support.
(Khan et al. 2020)	Agricultural financing. Dissemination of adequate and timely climate information
(Mahmood et al., 2020)	improving farmers' education levels, and climate-specific extension services.

Source: Author's own

It is worth mentioning that some of the listed adaptation options are already in use in some communities. However, they can be equally useful in other areas as well. Therefore, there is a need to increase awareness

about available climate change adaptation options and their effectiveness in different locations. This will enable vulnerable communities to adapt to climatic changes.

III. CONCLUSIONS AND POLICY IMPLICATIONS

This study draws some useful conclusions based on the observations of the reviewed adaptation case studies. The case studies show that the exposed communities seem to be cognizant of the climate risk. However, they are not fully aware of the level and intensity of risk and its potential for possible damage. Since 2005, the National Disaster Management policy has had a paradigm shift from a highly centralized and top-down disaster risk approach to an integrated disaster management policy[6] and incorporates preparedness and mitigation through stakeholder involvement at the local and provincial levels. Our findings provide important insights and valid implications for the National Disaster Management Plan by indicating a knowledge gap that precludes the communities from precisely assessing and responding to climate risk, especially in rural and remote socio-cultural settings.

The case studies indicate that poverty precludes poor households from an adaptation that has a bearing on the households' affordability and adaptation cost, while adaptation is vital and critical for poor households to avoid further damage. Therefore, some support or safety nets may help the vulnerable segments in adapting to the changing climate. Additionally, despite the communities' readiness, the use of financial products; for example, crop insurance and agriculture credit for climate change adaptation in Pakistan, is negligible.

The inadequate use of social capital, limited credit access, landholding status, financial constraints, inadequate resource allocation for adaptation, lack of timely access to climate risk information, farm advisory services, and poor understanding of the role of institutions are some of the factors that deter the adaptation process in rural communities of Pakistan. Agriculture extension can play a crucial role in this regard to enable farmers to adapt by providing information and technical assistance

[6] http://cms.ndma.gov.pk/

on some of the aforementioned areas. Hence, improvement in outreach, technical capacity, and efficiency of the extension department is critical.

The key adaptation drivers that largely define adaptive behaviour in study areas comprise access to sustainable livelihoods, basic amenities, and agricultural extension services. Furthermore, the geography of resilience in Pakistan is location-specific and varies with communities' access to basic services. Therefore, there is a need to focus on key aspects of adaptation decisions and invest more efforts to adopt a holistic, comprehensive and integrated approach to adaptation implementation. The undisrupted supply of the basic service is a key to resilience as it allows for generating an autonomous response that is more effective and robust to adjust to hazards successfully. In addition, basic services define the success of interventions in the wake of the disasters. Hence, the investment to improve the even access and supply of basic infrastructure is critical to the success of the development as well as climate adaptation.

The research offers an interesting policy insight regarding the success of adaptations in rural areas of Pakistan; that the households prefer well-known, easy, and short-run adaptation measures. This implies that they are less likely to adopt technologies that are complex, and their decision-making is for the short run. Additionally, given the adaptation options, the households choose house construction and repair over the rehabilitation of other assets. This confirms that rural farm households are risk-averse and indicates that they prioritize adaptation actions.

The research notices that due to a lack of awareness, farm households are not using all available adaptation options. Therefore, there is a need to increase awareness about available climate change adaptation options and their effectiveness in different locations. This will enable vulnerable communities to better adapt to climatic changes. Moreover, the mixed-use of adaptation measures is found to be more useful than the single adaptation strategies. Thus, the diversification of the adaptation portfolio can yield better results. The outcomes of this review provide some valid prospects by considering effective and local adaptation measures for agriculture and spreading awareness among the population about the possible actions and measures such as:

The role of the government should be proactive and inclusive towards minimizing the knowledge-sharing gaps between the local stakeholders and incorporating local and effective adaptation techniques adaptation in policies. Also, the dissemination of local knowledge of the local farming community about their climate-related experiences among the community members would contribute to formulating tailor-made, local, and sustainable adaptation measures in agriculture. Further, Banks, microfinance institutions, and other relevant investors should come forth and develop and implement agriculture finance strategies and provide financial services like loans and insurance to promote a resilient agriculture finance structure in Pakistan.

The review paper is based on a large sum of case-studies-based research on climate change autonomous adaptation among farmer households in Pakistan; however, it is further suggested that a deeper evaluation of risk-wise awareness and relevant adaptation should be conducted since most of the current research focuses on specific aspects yet lacks detailed examination of specific risks to the crops and local adaptation to climate change in Pakistan.

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