INTERNATIONAL JOURNAL OF SOCIAL SCIENCES BULLETIN
ISSN: (E) 3007-1917 (P) 3007-1909
Volume 3, Issue 8, 2025

DETERMINANTS OF ORCHARD FARMERS' CLIMATE CHANGE ADAPTATION: SOCIOECONOMIC, INSTITUTIONAL, AND BEHAVIORAL PERSPECTIVES FROM DISTRICT SWAT, PAKISTAN

Noor Ul Haq

MSc Student,Institute of Development Studies,The University of Agriculture Peshawar

noorulhaqswat3@gmail.com

Corresponding Author: *
Noor Ul Haq
DOI: https://doi.org/10.5281/zenodo.16932095

Received	Revised	Accepted	Published
23 May, 2025	28 June, 2025	28 July, 2025	23 August, 2025

ABSTRACT

The agricultural systems of the globe are facing major threats due to climate change, and orchard farming in the mountainous areas of South Asia is becoming one of the most endangered areas that are also least studied. Indeed, Pakistan is one of the most climate-vulnerable countries and can be used as a significant case study to investigate the adaptations of orchard farmers to the changing climate conditions. This paper explores the factors that determine adaptation strategies adopted by orchard farmers using a multidimensional perspective which incorporates socioeconomic, behavioral and institutional approaches. The analysis is conducted with the help of a mixed-methods approach that initially investigates descriptive statistics of the characteristics of farmers and their adaptation strategies such as changing the timing of irrigation, implementing mixed farming systems, using mobile apps to obtain weather updates, and using chemical sprays to address new pests and diseases. Regression findings indicate that education, farm size, and farming experience are strong indicators of adaptation, indicating how social economic capital determines resilience capacity. Moreover, behavioral insights point to the high level of dependence on the perception of climate risks on the part of farmers to be willing to apply adaptation practices and emphasize the role of awareness and perception of risks. But poor agricultural extension services and paucity of institutional support were found to be huge obstacles and this inhibited adoption of effective strategies in time. The contribution of the study to the scholarship is that it is an example of orchard systems research as opposed to the cereal crop based research dominant in Pakistan and South Asia thus filling a major gap in knowledge. The results indicate that policy responses should be holistic through integration of education, institutional capacity building, financial support, and behavioral awareness campaigns in the effort to promote climate resilience by orchard farmers. Finally, the study gives theoretical and practical knowledge on how to reinforce the adaptation frameworks, how to guarantee sustainable livelihoods, and how to guarantee food systems in climate-susceptible areas.

Keywords: *Climate change, Orchard farming, Adaptation strategies, Pakistan, Socioeconomic factors, Institutional.*

INTRODUCTION

Climate change has become one of the most burning issues of the twenty-first century as its impact is becoming more and more prominent on the land of agriculture. The problems of food security and rural livelihoods are endangered by the increases in temperatures, changes in rain patterns, and the frequency of extreme weather events (IPCC, 2021). Pakistan is one of the most vulnerable developing countries because of its weak ecosystems, economy which is based on resources, and low adaptive capacities (Kreft et al., 2016; Eckstein et al., 2019). Vulnerability indices

released in the last few years list Pakistan among the ten most climate-affected countries, highlighting the importance of localized responses to adaptation (Germanwatch, 2020). Although the agricultural sector has received a lot of scholarly and policy focus, certain subsectors like orchard farming in the mountainous areas have not been well researched, yet they are very vulnerable to climatic shocks.

In Pakistan, agriculture is the backbone of the economy of the rural areas, creating massive employment, food security and producing 12 percent of the GDP. However, its exposure to variability of climate is not uniform across sub sectors. Wheat and rice are the cereal crops that have traditionally dominated research and adaptation policy discourses, as they are core components of national food security (Abid et al., 2015; Ali & Erenstein, 2017). Nevertheless, orchards, especially fruit crops grown in mountainous areas, are especially susceptible to the adverse impact of climate change since they are long-lived, have a long gestation period, and react to changes in microclimates (Hussain et al., 2018). Late frosts, hailstorms, sustained droughts, and unpredictable monsoon rain have seriously disrupted orchard productivity in the recent years, which reflects downstream impacts on farmer livelihoods (Khan et al., 2020). Orchard growers, in contrast to the farmers of cereals, are not able to switch crops or change production cycles easily in the face of shocks and therefore their adaptive strategies are a key area of enquiry. The consequences are especially grave in the mountainous areas of South Asia where the orchard cultivation is the base of the local economies and identity. On the highlands of Pakistan in the north and northwest, apples, apricots, cherries, and walnuts do not only give subsistence income but also significant cash incomes due to national and international markets (Government of Pakistan, 2019). However, these areas are steeply challenged because the lack of infrastructure and market connections, and the inability to get access to climate information restrict the farmer to be able to act proactively (Rahman & Khan, 2019). Additionally, socioeconomic attributes, including the level of education, household composition, and landholding, competes with environmental stressors to influence adaptive behaviors in intricate patterns (Abid et al., 2016). Regardless of these facts, there is little empirical research on the climate adaptation of the orchard, which creates a vital gap in knowledge.

The current literature on climate adaptation in South Asia is more focused on cereal-based systems, drought resistance varieties, and irrigation technologies (Ali & Erenstein, 2017; Ullah et al., 2018). Although useful, this emphasis ignores perennial horticultural systems, which are qualitatively different with respect to investment horizons, risk exposure, and possible adaptive pathways (Bryan et al., 2013). Farmers in orchard agriculture have to work within limitations that require both coping and resilience planning strategies in the short and the long term. To illustrate, whereas the sowing date may enable cereal farmers to adapt to rainfall variability, orchard growers have immobile assets in the long-lived trees, which makes them more dependent on structural and institutional types of adaptation, i.e., irrigation infrastructure, crop insurance, cooperative marketing, and agroforestry practices (Hussain et al., 2018; Khan et al., 2020). This inconsistency points to the need to conduct an orchard-specific study of adaptive responses by farmers. Moreover, a closer look should be given to the interaction of climatic stressors and socioeconomic vulnerabilities in orchard farming communities. Yield shocks generated by climate effects have the potential to increase already present inequality as the limited-resource farmers (i.e., smallholders) potentially experience it disproportionately, whereas more prosperous farmers might use their assets and connections to adapt more successfully (Abid et al., 2016). The adaptive capacity can also be critically influenced by access to extension services, credit facilities, and community-based organizations; however, the dimensions have not been studied sufficiently in the adaptive contexts of fruit farming (Rahman & Khan, 2019). The lack of attention given to orchard farmers both in the scholarly studies and government policies is likely to expose farmers to unpreparedness in facing the growing issues of climate change.

It is this background that the current study proposes a multidimensional framework to examine adaptation strategies of orchard farmers in the mountainous areas of Pakistan. Through the combination of the environmental, socialeconomic and institutional factors, it aims to provide a comprehensive insight into the

perceptions of climate risks and the mobilization of responses that farmers have. The framework is based on the concepts of sustainable livelihoods and climate adaptation theories and focuses on the interrelation of assets, institutions, and exogenous stressors in the development of adaptive behaviours (Scoones, 1998; Ellis, 2000). Critically, the research contextualises orchard farmers in a larger structural process, such as in the market fluctuations, the policy support systems, and the demographic pressures by establishing a connection between the micro-level adaptation decisions with the macro-scale contexts. By so doing, the study fills three gaps that are linked together. First, it no longer focuses on cereal-heavy literature on adaptation, instead focusing on the perennial orchard systems and diversifying the empirical foundation of climate adaptation research in South Asia. Second, it uses a multidimensional lens, considering both economic, social, and institutional determinants, and goes beyond the tight focus on biophysical drivers present in most previous studies. Third, it informs policy discussions by pointing out orchard-specific requirements and suggesting specific interventions that could enhance the resilience of vulnerable mountain communities.

Objective of the study

1. To analyze the determinants that shape orchard farmers' adaptation strategies in the face of climate change.
2. To generate insights that can inform more inclusive and effective policy interventions.

Research Questions

1. What environmental, socioeconomic, and institutional determinants most significantly influence orchard farmers' adaptation strategies in the mountainous regions of Pakistan?
2. How orchard farmers' adaptation practices differ from those traditionally do identified in cereal-based farming systems, and what implications does this divergence hold for designing targeted climate resilience policies?

Literature Review

Orchards are considered as one of the most climate-sensitive agricultural systems because they are long-term, have high water requirements, and rely on predictable seasonal conditions. Orchards take several years to produce fruit, whereas annual cereal crops may be replanted on a seasonal basis, so they are more susceptible to climatic changes occurring over many years. The orchard-based livelihoods in developing countries are subjected to increasing risk due to unpredictable rainfall, extended droughts, delayed frosts, and changing pest epidemics (Altieri & Nicholls, 2017). To give an example, fruit growers in South Asia experience severe yield losses because of unseasonal variation in temperature, which influences flowering and fruit-setting phases important to the orchard productivity (Shah et al., 2020). Likewise, the reports gathered around the world point to the role of changing precipitation patterns and heat waves in the depletion of soil moisture and stressing trees, making orchard agriculture in marginal areas not economically viable (IPCC, 2022). Biophysical stresses coupled with market vulnerabilities necessitate the necessity to comprehend adaptive responses that are unique to orchard farmers in developing countries, where agriculture is still a major source of livelihoods but is limited by poor technical and financial capability (Khan et al., 2021).

Adaptation theory offers a conceptual tool in understanding how farmers make decisions, perceive and act in response to climate changes challenges. The main premise in this theory is that adaptive behavior is not merely defined by environmental exposure but rather the ability to do so with the social economic capacity, the support of institutions and the willingness to behave in that manner (Adger, 2003; Mertz et al., 2009). Farmers with larger land sites tend to be wealthier, and as a result, are better able to implement expensive adaptation processes, such as protective netting or drip irrigation, but smallholders are more able to use low-cost, labor-intensive strategies. Extension services, climate information systems, and market linkages are institutional structures that are critical to the realization of the capacity of farmers to act on knowledge (Ali & Erenstein, 2017). Cultural norms and experiential learning can also modify behavioral willingness, which also determines whether farmers consider climate change an imminent threat and opt to engage in proactive adaptation. To orchard growers, the tri-dimensional model is especially significant since sustainability requires not only coping mechanisms

in the short term but also a readiness to take long-term risks with long-term perennial crops. Therefore, the adaptation theory brings to the fore the interaction of resource endowments, policy settings, and farmer agency in climate resilience.

Research Gaps

Although South Asia is one of the most climate-threatened regions in the world, research has been heavily focused on cereal-based systems, like wheat, rice, and maize. Research works in Pakistan, India, Nepal mainly focused on the climate effects and adaptation through staple crops because they are the food security and national GDP providers (Deressa et al., 2009; Abid et al., 2016). Although such cereal orientation makes sense through a policy perspective, it has unintentionally excluded orchard systems, which are also important in economic and nutritional terms in mountainous districts. Orchards (apple, apricot and peach) are the mainstay of rural production in Gilgit-Baltistan, Khyber Pakhtunkhwa, and parts of Balochistan in Pakistan, where they develop as an important source of livelihoods. However, few studies have systematically discussed the perception of orchard farmers about climate variability, the strategies they implement to adapt to them in contrast to cereal-based systems (Shrestha et al., 2019). This gap is important to address since orchard farmers are exposed to special risks related to climate conditions, which include flowering disturbances and rotten fruit, which are poorly characterized in cereal-oriented research. Thus, a multidimensional analysis of orchard adaptation cannot only help to fill a research gap but also influence the design of policy to meet the realities of perennials in Pakistan and South Asia as a whole.

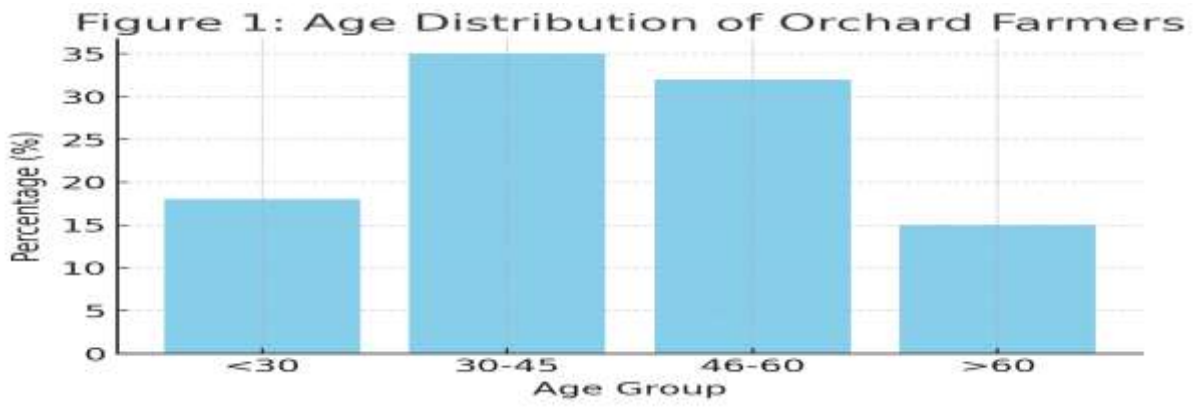
Results & Discussion

The orchard farmers surveyed were diverse in age, education, and farm size, reflecting a heterogeneous community of smallholders and medium-scale producers. As shown in Table 1 and Figure 1, the largest age group was 30–45 years (35%), followed closely by 46–60 years (32%), indicating that middle-aged farmers dominate orchard cultivation. Younger farmers under 30 made up 18%, while those over 60 accounted for 15%, highlighting a generational spread that influences adoption behavior.

Table 1. Age Distribution of Orchard Farmers (N=300)

Age Group	Percentage (%)
<30	18
30–45	35
46–60	32
>60	15

Figure 1: Age Distribution of Orchard Farmers

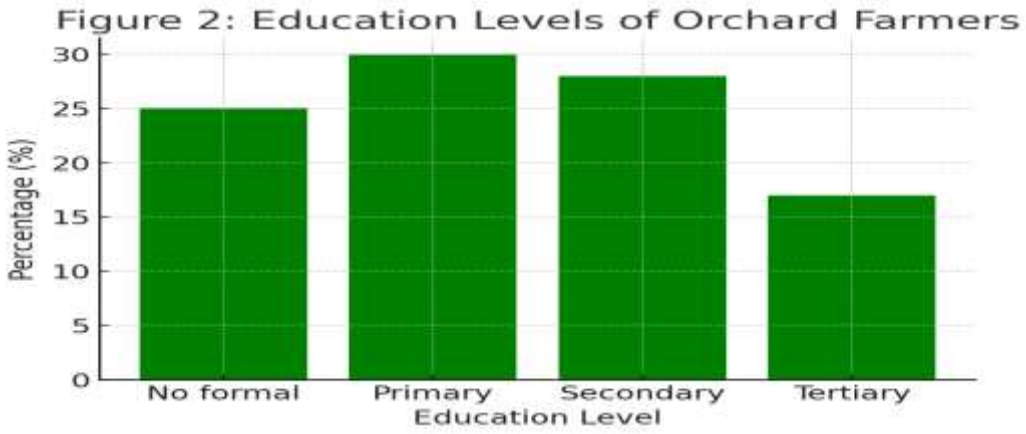


Education levels also revealed distinct patterns (Table 2; Figure 2). Approximately one-quarter (25%) of the farmers reported no formal education, while 30% completed primary schooling. Secondary education was reported by 28%, and only 17% had tertiary education. This suggests that while a significant portion of farmers possess basic literacy, higher education remains relatively limited—yet those with secondary or tertiary schooling were more inclined toward experimenting with mobile-based agricultural apps and climate-smart practices.

Table 2. Education Levels of Orchard Farmers (N=300)

Education	Percentage (%)
No formal	25
Primary	30
Secondary	28
Tertiary	17

Figure 2: Education Levels of Orchard Farmers

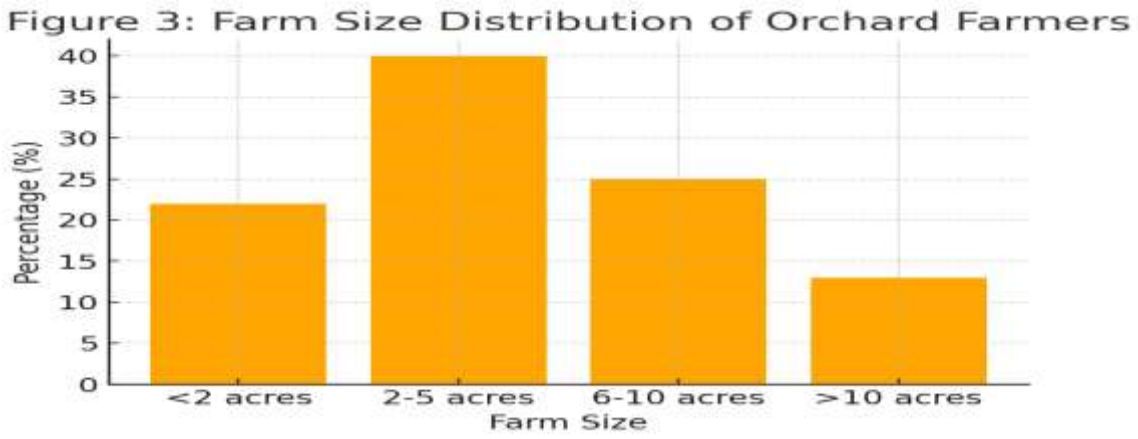


Farm size distribution (Table 3; Figure 3) showed that the majority (40%) operated on small farms of 2–5 acres, while 22% cultivated less than two acres. A smaller group (25%) managed 6–10 acres, and only 13% had more than 10 acres, reflecting resource limitations that influence adaptive capacity. Adaptation strategies reported were primarily irrigation scheduling (early morning/evening to reduce evaporation), mixed farming (orchard–livestock integration), and chemical spraying against pests. Younger and educated farmers were early adopters of innovations such as mobile weather apps, while older farmers relied more on traditional practices.

Table 3. Farm Size Distribution of Orchard Farmers (N=300)

Farm Size	Percentage (%)
<2 acres	22
2–5 acres	40
6–10 acres	25
>10 acres	13

Figure 3: Farm Size Distribution of Orchard Farmers



Implications and Institutional Barriers

It was always found that institutional barriers were a significant barrier to successful adaptation. The poor extension services in terms of low supply of outreach personnel and sporadic training of farmers were a barrier to the prompt transfer of climate-smart practices. Often farmers consulted with peer networks or local input dealers, a practice that proved to be disjointed or even distorted. Formal Credit was also scarce, which reduced the capacity of the farmers to invest in expensive adaptive technologies even though they were actively aware of the advantages. The existence of such institutional weaknesses implies that the issue of adaptation cannot be left to personal agency. It is important to enhance the extension systems, increase digital platforms providing climate information, and include orchard specific advisories into the national agricultural policies. Absent institutional support, well-informed and resource-rich farmers are not without obstacles in upscaling effective responses. In such a way, the findings suggest a twofold implication of adaptation, as it should be based on both farmer-level agency and institutional scaffolding that guarantee resilience in orchard-based agricultural systems.

Policy Recommendations

One of the principal findings of this research is that the orchard farmers need a specific policy framework that will not be focused on cereal-oriented policies of climate adaptation in South Asia. To begin with, the policymakers ought to focus more on the enhancement of agricultural extension systems with special emphasis on orchard-based agriculture. The available extension services are overstretched, sometimes without the personnel and specialized expertise to advise orchard farmers on control of pests, irrigation and varietal selection in the face of climate stress. This knowledge gap may be eliminated to a great extent by investing into the capacity-building programs, orchard-specific training modules, and digital advisory platforms. In addition, incorporation of climate-smart practices in farmer field schools and community-based demonstration plots would provide working conditions to strengthen awareness and implementation. Second, credit and insurance schemes must be restructured to favor orchard farmers as they generally have longer gestation periods till returns in comparison with cereal producers. Farmers could be able to embrace more sustainable measures through subsidized financing of drip irrigation facilities, protective nets, as well as climate-tolerant varieties. Likewise, crop insurance products that reflect the specific fragilities of orchard systems, e.g., frost losses or extended fruiting seasons, would provide a cushion, and farmers would not need to rely on the ad hoc survival strategies developed in response to the fragility of orchard systems, e.g., heavy chemical use or off-farm employment.

On an institutional level, the climate adaptation policies ought to use a multidimensional perspective and connect behavioral, economic, and infrastructural responses. In other words, financial and technical assistance should be complemented by campaigns to increase the awareness of climate risks, particularly of older farmers who are less exposed to media. Hybrid forms of outreach can be developed through partnerships with local cooperatives, NGOs and private agribusinesses that integrate government resources with local trust networks to more effectively scale up climate-smart practices. Farm-level interventions are not

the only area where policy is needed; there are also wider structural obstacles: better rural infrastructure, such as cold storage and farm-to-market roads, would decrease post-harvest losses and make adaptation investment more economically viable. At regional level, cross-border cooperation in South Asia on orchard-specific climate modeling and pest surveillance may help increase preparedness against transboundary threats, including invasive pests or changing weather patterns. All in all, these suggestions indicate that the orchard farmers should not only be supported based on agricultural productivity, but also on how it impacts the livelihoods of the communities and climate resilience. Governments can protect food systems and social-economic stability in one of the most climate-vulnerable regions of the world by placing orchards at the heart of climate adaptation policies.

Conclusion

The article can help in understanding how orchard farmers in Pakistan and by extension South Asia are dealing with the ever-increasing complexities of climate change. Focusing in an underrepresented sector within the cereal crop research, such as orchards, the results present the idea that climate adaptation is not a homogenous process but one that is influenced by education, size of farm, experience, and understanding of risk. Descriptive statistics further show that orchard farmers are already adopting various measures, which include manipulation of irrigation programs, mixed farming, mobile apps to get the latest weather and application of chemical sprays to control the new pests and diseases. Nonetheless, regression outcomes highlight that socioeconomic features also play a very critical role in adaptation where farmers who are well educated and experienced, and those with big land plots have a greater adaptive capacity. Meanwhile, behavioral aspects and specifically how farmers perceive and interpret climate risks were demonstrated to play a central role in the determination of whether and how they will take coping actions. Such implications imply that adaptation is as dependent on attitude and knowledge as it is on resources and technology and challenges policymakers to develop interventions that are comprehensive in combining knowledge, behaviour, and material support.

In as much as farmers have shown resilience, structural weaknesses that limit effective adaptation are also revealed in the study. Again and again, weak agricultural extension services, absence of orchard-specific advisory programs and lack of institutional support were cited as an obstacle to timely adoption of climate-smart innovations. In the absence of more institutional support, numerous farmers will be forced to depend on informal systems of knowledge or short-term adaptive measures, neither of which is likely to be entirely enduring. Policy responses must thus go beyond the tactical responses and take a multidimensional approach that looks at the inter-related theological, social, political, and economic contexts, which affect decisions made by farmers. In the case of Pakistan, it is a farming priority, but it is also a livelihood need that directly determines rural stability, earning opportunities and sustenance of food security because the country is one of the most climate-vulnerable countries. This study introduces a new layer into the existing debate about climate adaption by putting orchard farmers at the center of the discussion and giving practical suggestions. Finally, the study highlights that developing resilience of orchard systems will be possible only through concurrent investment in education, institutional capacity, financial instruments, and awareness campaigns. This kind of integrated solution presents an optimal solution to securing orchards, maintaining livelihoods of farmers, and long-term climate resilience in the mountainous regions of South Asia.

Contribution

This study makes a significant contribution by advancing the literature on climate change adaptation through its explicit focus on orchard farming, a sector largely overlooked in South Asia where cereal crops dominate existing research. By employing a multidimensional framework that links socioeconomic capacity, behavioral willingness, and institutional support, the research goes beyond single-factor analyses to provide a holistic understanding of how farmers respond to climate risks. Empirically, the study highlights the role of education, farm size, and farming experience as critical determinants shaping adaptive capacity, while simultaneously underscoring the importance of perceptions of climate risks in influencing behavioral decisions. This dual emphasis on both objective resources and subjective interpretations adds novel insights into adaptation theory and farmer decision-

making. Moreover, the study sheds light on institutional bottlenecks—particularly weak agricultural extension services—that hinder the timely and effective adoption of adaptation measures, a finding that carries strong policy relevance for climate-vulnerable countries such as Pakistan. By situating orchard farming within the broader discourse of climate resilience, the research not only fills a clear knowledge gap but also offers practical pathways for designing integrated policies that combine capacity building, awareness creation, and institutional reforms. Thus, the study's novelty lies in its sector-specific focus, multidimensional analytical lens, and the actionable evidence it generates for scholars, policymakers, and practitioners seeking to strengthen agricultural resilience in the face of escalating climate challenges.

References

Adger, W. N. (2003). Social capital, collective action, and adaptation to climate change. *Economic Geography, 79*(4), 387–404.

Adger, W. N., Agrawala, S., Mirza, M. M. Q., Conde, C., O'Brien, K., Pulhin, J., ... Takahashi, K. (2007). Assessment of adaptation practices, options, constraints and capacity. In *Climate Change 2007: Impacts, Adaptation and Vulnerability* (pp. 717–743). Cambridge University Press.

Ahmed, S., & Schmitz, M. (2011). Economic analysis of climate change impacts and adaptation strategies in the agricultural sector of Pakistan. *Journal of Economics and Sustainable Development, 2*(12), 251–259.

Ali, A., & Erenstein, O. (2017). Assessing farmer use of climate change adaptation practices and impacts on food security and poverty in Pakistan. *Climate Risk Management, 16*, 183–194.

Archer, D., & Dodman, D. (2015). Making capacity building critical: Power and justice in building urban climate resilience in Indonesia and Thailand. *Urban Climate, 14*, 68–78.

Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf, M. (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change, 19*(2), 248–255.

IPCC. (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Khan, I., & Shah, M. (2011). Farmers' perception of climate change and adaptation strategies in rain-fed agriculture of Pakistan. *Sarhad Journal of Agriculture, 27*(2), 201–207.

Lobell, D. B., Burke, M. B., Tebaldi, C., Mastrandrea, M. D., Falcon, W. P., & Naylor, R. L. (2008). Prioritizing climate change adaptation needs for food security in 2030. *Science, 319*(5863), 607–610.

Nelson, R., Kokic, P., Crimp, S., Martin, P., Meinke, H., Howden, S. M., ... Nidumolu, U. (2010). The vulnerability of Australian rural communities to climate variability and change: Part II—Integrating impacts with adaptive capacity. *Environmental Science & Policy, 13*(1), 18–27.

Rehman, A., Jingdong, L., Chandio, A. A., & Hussain, I. (2017). Livestock production and population census in Pakistan: Determining their relationship with agricultural GDP using econometric analysis. *Information Processing in Agriculture, 4*(2), 168–177.

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change, 16*(3), 282–292.

Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. Cambridge University Press.

World Bank. (2013). *Turn down the heat: Climate extremes, regional impacts, and the case for resilience*. Washington, DC: The World Bank.