# Assessing the Impact of Climate-Smart Adaptation Strategies on Sustainable Agriculture and Food Security in Punjab amidst Climate Change

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**Abstract:** *This article examines climate-smart adaptation strategies and their impact on agriculture and food security in Punjab's Chakwal District, Pakistan. The study assesses climate change effects, evaluates adaptation methods, and identifies challenges for scaling up. Results show climate change is harming agricultural production, affecting weather patterns and reducing yields. Though climate-smart strategies are implemented, their effectiveness needs improvement. Lack of farmer awareness hinders scaling up. Findings stress raising awareness, providing support, and strengthening institutions for adoption. Policymakers, NGOs, and stakeholders can benefit from the study's implications. Efforts should focus on increasing awareness, support, and institutional strengthening for effective implementation. The survey provides insights for future interventions and policies to boost climate resilience in the region.*

**Key Words:** Climate-smart Adaptation Strategies, Sustainable Agriculture, Food Security, Climate Change Impacts

## Introduction

Climate change, by means of defined by the Intergovernmental Panel on Climate Change (IPCC) in 2014, signifies a long-term revolution in global or regional climatic patterns caused primarily by human acts such as coal combustion, deforestation, and manufacturing processes (IPCC, 2014). The significances of climate change are vast and comprehensive, touching everything from ecologies and biodiversity to human health and livelihoods.

One of the areas where the consequences of climate change are particularly evident is agriculture and food security. Fluctuations in temperature, rainfall, and extreme weather conditions can all have significant impacts on crop yields, water accessibility, and production of food. In Pakistan, a country that relies heavily on agriculture, and by now, the results of climate change are being seen.

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Climate-smart agriculture (CSA) refers to the creation of the necessary technical, policy, and investment conditions that promote sustainable agricultural development for ensuring food security in the face of climate change, as defined by the Food and Agriculture Organization (FAO) in 2013. This approach involves a range of practices and strategies, including the practice of climate-resilient crops, preservation agriculture, crop diversification, and integrated pest management, among others.

Overall, climate-smart adaptation strategies have the potential to help smallholder farmers in Pakistan familiarize themselves with the effects of climate variations and ensure the sustainability of their farming practices. By promoting practices that are robust to climate change, farmers can increase their yields and incomes while also reducing greenhouse gas discharges and contributing to global efforts to alleviate the impacts of change in climate.

Climate change is a comprehensive phenomenon in the whole world that has been extensively studied in recent years (IPCC, 2018). It states long-term deviations in weather situations, including temperature, rainfall, and wind. Climate change is instigated by various reasons, including anthropological events such as boiling fossil fuels, deforestation, and industrialization (USGCRP, 2017). Agronomy, health, and the environment are just a few of the many fields that are being impacted by climate change (World Bank, 2021).

Agriculture or farming is one of the utmost affected segments by climate change (FAO, 2020). Agriculture is impacted by changes in climate in multiple ways, including changes in rainfall patterns and also increase in the frequency of harmful weather like famines and floods and, shifts in the incidence and geographic distribution of pests and diseases (IPCC, 2019) These properties have far-reaching implications on security of food, especially in emerging countries, where agriculture is a primary foundation of livelihood for most people (FAO, 2020).

Climate-smart adaptation strategies are interventions that seek to build flexibility in agricultural systems regarding climate change while also enhancing food security (FAO, 2013). These strategies include the adoption of climate-resilient crops and livestock, improving soil health, and the use of appropriate technologies to manage water and other natural resources (FAO, 2013).

According to the Government of Pakistan (2017), life-threatening weather events and deviations in rainfall patterns are now distressing the country's agricultural sector. Smallholder farmers, who make up the majority of the farming community in Pakistan, are particularly vulnerable to these impacts. The changing climate can result in crop failures, reduced yields, and lower incomes for farmers, which can have devastating effects on their families and communities.

To address these challenges, climate-smart adaptation strategies have been developed to help farmers in Pakistan mitigate the impacts of change in climate and ensure the sustainability of their farming practices. Climate-smart farming is a tactic that purposes to upsurge production and flexibility, though also reducing greenhouse gas secretions and adapting to climate change.

Punjab's Chakwal District is an agricultural region in Pakistan that is exposed to the consequences of climate variations (World Bank, 2018). The region experiences erratic rainfall patterns, which affect crop yields and food security (Majid et al., 2021). Embracing climate-smart working policies in this region could help to improve resilience and flexibility to climate change and expand food safety (FAO, 2013).

Crop diversification is another strategy that has been used in Chakwal, which involves growing a variety of crops rather than relying on a single crop. This can help to spread the hazard of crop disasters and reduce the impacts of pests and diseases. Additionally, the use of drought-tolerant crops, which are better able to withstand the impacts of water scarcity, has been promoted in the district.

Assessing the influence of climate-smart adaptation measures and strategies on sustainable farming and food safety in Punjab's Chakwal District amidst climate change involves conducting research to evaluate the effectiveness of different adaptation strategies (FAO, 2013). This research could involve the use of both qualitative and quantitative procedures, with surveys, discussions in focus groups, and investigational trials (FAO, 2013).

The ultimate goal of the present research is to categorize the most effective working approaches that could be scaled up to improve food safety and enhance resilience to changes in climate in Punjab's Chakwal District. The findings of this research could also inform policy decisions aimed at promoting sustainable agriculture and, food security in the region (FAO, 2013). The intention of this research is to discover the effectiveness of climate-smart adaptation plans in promoting maintainable farming and, food security in the Chakwal District of Punjab, Pakistan, in the agenda of environmental changes. There is a lack of investigative studies on the effectiveness of CSA (climate-smart adaptation) plans to promote sustainable agriculture and the shortage of food in Pakistan, particularly in the Chakwal District. This study tried to find out answers to the questions, given below:

What are the critical impacts of climate change on farming and food safety in the Chakwal District, Pakistan?

- What climate-smart adaptation strategies have been implemented in the Chakwal District, and how effective have they been in promoting maintainable agriculture and food safety?
- What opportunities and challenges exist in the Chakwal District for scaling up climate-smart adaptation strategies?

### Research Objectives

- To identify key climate change bearings on agriculture and food safety in the Chakwal District, Pakistan.
- To assess the effectiveness of climate-friendly working strategies in promoting sustainable farming and food safety in the Chakwal District.
- To identify the challenges and opportunities for scaling up climate-smart adaptation strategies in the Chakwal District.

### Expected Outcomes

This research aims to provide insights into the effectiveness of smart adaptation strategies for climate in promoting sustainable farming and food safety in the Chakwal District of Punjab, Pakistan. The findings of this research will contribute to the existing knowledge on Pakistan's

agriculture economy is adjusting to change in climate, mainly in the situation of smallholder farmers. The results will also provide recommendations for policymakers and practitioners on scaling up climate-smart adaptation measures in the Chakwal District and other similar contexts.

### Literature Review

The literature review presents a comprehensive evaluation of the impact of climate change on agriculture and food security in Pakistan and the adaptation and mitigation strategies that have been employed to address these challenges. The following is a brief of the significant conclusions from the reviewed articles:

Rana, M. W., et al. (2020) analyzed the impact of climate change on agriculture and food security in Pakistan and evaluated the adaptation strategies employed to address these challenges. The study found that changes in climate had a negative impact on agricultural production and, suggested that there is a need for plan intervention to sponsor sustainable agricultural training and decrease the susceptibility of farmers to climatic variations.

Zulfiqar, F., et al. (2020) revised the consequence of climate variations on the yields of crops in Pakistan and the measures taken to adapt to these changes. The study found that climate change holds a significantly negative influence on crop production, and suggested that there is a need for adaptive measures such as crop diversification and the use of drought-resistant crops to address these challenges.

Hussain, M., et al. (2019) evaluated the effect and influence of climate alteration on crop manufacture and food safety in Pakistan and identified the adaptation policies that have been instigated to address these challenges. The study further found that climate change keeps a negative impact on crop manufacture and food security, and suggested that there is a need for strategic intervention to endorse sustainable agricultural practices and reduce the exposure of farmers to climate revolution.

Khan, M. A., et al. (2019) provided an overview of the impact of the change in climate on food safety in Pakistan and the actions that have been taken to address these challenges. The study found that climate change had an opposing

impact on food safety in Pakistan, and suggested that there is a requirement for policy intervention to promote sustainable agricultural practices and lessen the susceptibility of farmers to climate change effects.

Iqbal, M. M., et al. (2018) evaluated the impact of change in climate on crop production in Pakistan and the various adaptation plans that have been employed to address these challenges. The study found that climate variations had a harmful effect on crop production, and suggested that there is a need for adaptive measures such as the use of drought-resistant yields and the implementation of conservation agriculture practices to address these challenges.

Haider, H., et al. (2018) provided an outline for the impacts of climate revolution on crop productivity and food security in Pakistan and the various adaptation strategies that have been employed to address these challenges. The study found that the climate revolution damaging effect on the productivity of crops and, food shortage in the region of Pakistan, and suggested that there is a critical need for adaptive measures such as crop diversification and the embracing of sustainable farming practices to address these challenges.

Ali, M. B., et al. (2017) discussed the impact of climate change on agriculture and the various mitigation strategies that have been implemented to address these challenges. The study initiated that climate variations have an undesirable impact on agronomy, and suggested that there is a need for mitigation measures such as reducing greenhouse gas emissions and promoting sustainable agricultural practices to address these challenges.

Raza, S. A., et al. (2017) provided an overview of the impact of climate change on food security in Pakistan and the measures that have been taken to address these challenges. The study found that climate change has a negative impact on food security in Pakistan, and suggested that there is a need for policy intervention to promote sustainable agricultural practices and reduce the helplessness of farmers to changes in the climate.

Qaisrani, A., et al. (2016) evaluated the impact of the revolution in climate on food safety and the various adaptation plans that are being employed to address these challenges. The study concluded that changes in climate-damaging influence food security, and suggested that there is a need for adaptive measures such as crop diversification.

In recent years, environmental change and its potential influences on food security have become increasingly important topics of discussion. To address these issues, a number of revisions have been steered to evaluate the impact of friendly agriculture practices on sustainable food security.

One such study, conducted by Ahmad, Azeem, Khan, and Hussain in 2021, presents a review of the literature on the possible results of climate-smart farming practices to contribute to sustainable food security. The authors emphasize the importance of context-specific approaches to climate-smart agriculture and highlight the need for integrated interventions that take into account the socio-economic and environmental factors affecting food security.

Another study, conducted by Ahmad, Hussain, Azeem, and Khan in 2020, assesses the power of the CSA (climate-smart agriculture) policies on sustainable food security in Punjab, Pakistan. The authors find that climate-smart farming practices such as crop diversification and preservation agronomy have the potential to upsurge food manufacture and recover food security in the region.

Similarly, Alam, Naeem, Akhtar, Shahid, Hussain, and Suleri (2021) present a review of recent research on the bearing of change in the environment on agriculture. The authors highlight the potential negative impacts of environmental change on crop yields and emphasize the importance of adapting agriculture practices to mitigate these impacts and ensure food security.

Ali, Haq, Shahzad, and Hussain (2020) present literature, on the potential powers of climate change on food safety in Pakistan. The authors highlight the vulnerability of Pakistan's agriculture sector to extreme changes in climate and emphasize the necessity for CSA practices to mitigate these impacts and ensure sustainable food security.

Another study conducted by Ali, Khan, Abbas, Rehman, and Iqbal in 2020 presents an assessment of the literature on impactful changes in climate on agronomy and, food safety. The authors emphasize the need for adaptive plans such as crop variation and preservation agriculture to moderate the damaging effects of

climate variations on food manufacture and ensure maintainable food security.

Lastly, Anjum, Ali and, Hussain ([2019](#)) present a review of the potential impressions of environmental change on agriculture in Punjab, Pakistan. The authors highlight the weakness of Punjab's agriculture sector to weather situations and emphasize the need for adaptive approaches such as crop diversification and conservation agriculture to ensure sustainable food security.

Overall, these studies highlight the significance of climate-smart agriculture (CSA) practices and adaptive strategies in modifying the opposing impacts of the climate situation on food security. Furthermore, they emphasize the need for context-specific approaches and integrated interventions to address the complex socio-economic and environmental factors affecting food security.

## Methodology

This research used a mixed-methods style. Qualitative data was composed through detailed interviews with key stakeholders involved in agriculture and food security in the Chakwal District. These stakeholders may include farmers, agricultural extension workers, government officials, and NGOs. Additionally, focus group discussions were conducted with farmers and community members to increase a proper understanding of the local context and experiences.

Farmers of the Chakwal District were inspected for composing quantitative data. The survey will gather information on climate change impressions, current working strategies, and their effectiveness. Data was also collected on 200 farmers' perceptions of the trials and opportunities for advancing the adaptation strategies for climate revolution.

Data analysis involves a qualitative approach together with a quantitative method. Qualitative data was scrutinized using thematic investigation to identify key themes and patterns. Quantitative data was investigated by means of descriptive statistics and regression analysis, to evaluate the effectiveness of climate-smart adaptation strategies.

## Results and Discussion

### Descriptive Analysis

Based on the demographic information, the study sample consists mainly of male farmers with an average age of 38 years, who have primarily received primary and secondary education, and who own small landholdings ranging from 1-10 acres. These conclusions are identical to former research that has reported similar demographic characteristics among smallholder farmers in developing countries (FAO, 2018).

The study found that the majority of farmers (95%) had noticed changes in weather patterns, with rainfall patterns being the most commonly observed change (70%). This finding is consistent with Intergovernmental Panel on Climate Change (IPCC) statement states, that the rain patterns are changing in several regions, subsequently; there is an amplified frequency and concentration of droughts and overflows (IPCC, 2018).

The study also discovered that climate change has destructively squeezed agricultural production, with wheat being the most affected crop (60%). The finding is in line with other research that documented the detrimental effects of climate change on wheat yield (Lobell et al., 2011).

In terms of current adaptation strategies, crop diversification was the most commonly implemented strategy (40%), followed by improved water management (30%) and soil conservation practices (20%). The study found that these strategies were somewhat effective in vindicating the powers of change in climate, which is related to prior research that has shown that these strategies can reduce the negative influences of climate change on agricultural production (Lipper et al., 2014).

The biggest challenges to stepping up climate-smart adaptation policies identified in the study were a lack of awareness and knowledge among farmers (50%), accompanied by a lack of fiscal capital (30%) and a lack of institutional support (20%). These answers are corresponding with earlier results that have acknowledged these as key blockades to the implementation of friendly farming practices regarding climate (Sietz et al., 2012).

The study suggests that promoting awareness and education is the most promising opportunity

for scaling up climate-smart adaptation strategies (40%), followed by providing financial incentives (30%) and strengthening institutional support (30%). This finding is constant with preceding studies that have revealed the importance of raising awareness and providing incentives for the implementation of climate-friendly agriculture practices (van der Werf et al., 2016).

Finally, the research highlights the requirement for the government, NGOs, and other participants to provide technical assistance (50%), and financial support (30%), and promote partnerships and collaborations among stakeholders (20%) to support farmers in scaling up climate-smart adaptation strategies. These conclusions are dependable with former research work that has underlined the significance of multi-stakeholder partnerships and collaborations for endorsing the employment of climate-smart farming practices (FAO, 2018).

In conclusion, the study provides valuable insights into the existing state of climate change effects, variation policies, and trials handled by smallholder farmers in developing countries. The findings highlight the need for a multi-stakeholder approach that involves government, NGOs, and other stakeholders to promote awareness, provide incentives, and back the adoption of climate-smart cultivation practices amongst smallholder agriculturalists.

**Table 1**

*Section 1: Demographic Information*

| Demographic Information | Percentage |
|---|---|
| Age Range | 18-65 years |
| Average Age | 38 |
| Gender | |
| Male | 60% |
| Female | 40% |
| Education Level | |
| Primary Education | 35% |
| Secondary Education | 30% |
| Tertiary Education | 20% |
| No Formal Education | 15% |
| Occupation | |
| Farmers | 50% |
| Labourers | 25% |
| Government Employees | 10% |
| Other Occupations | 15% |
| Landholding Size | |

| Demographic Information | Percentage |
|---|---|
| 1-5 acres | 40% |
| 6-10 acres | 30% |
| 11-20 acres | 20% |
| More than 20 acres | 10% |

**Table 2**

*Section 2: Climate Change Impacts*

| Climate Change Impacts | Percentage |
|---|---|
| Notice changes in weather patterns? | 95% |
| Types of changes observed | |
| Rainfall patterns | 70% |
| Temperature | 20% |
| Extreme weather events | 10% |
| Negative impacts on agricultural production? | 80% |
| Crops most affected by climate change | |
| Wheat | 60% |
| Vegetables | 20% |
| Fruits | 10% |

**Table 3**

*Section 3: Current Adaptation Strategies*

| Current Adaptation Strategies | Percentage |
|---|---|
| Implemented climate-smart adaptation strategies? | |
| Crop diversification | 40% |
| Improved water management | 30% |
| Soil conservation practices | 20% |
| Effectiveness of strategies in mitigating climate change impacts | |
| Highly effective | 20% |
| Somewhat effective | 60% |
| Received support or assistance in implementing strategies? | |
| NGOs | 40% |
| Government agencies | 30% |
| No support | 30% |

**Table 4**

*Section 4: Scaling up Climate-Smart Adaptation Strategies*

| Scaling up Climate-Smart Adaptation Strategies | Percentage |
|---|---|
| Biggest challenges to scaling up climate-smart adaptation strategies | |
| Lack of awareness and knowledge among farmers | 50% |
| Lack of financial resources | 30% |
| Lack of institutional support | 20% |
| Opportunities for scaling up climate-smart adaptation strategies | |
| Promoting awareness and education | 40% |
| Providing financial incentives | 30% |
| Strengthening institutional support | 30% |
| How can government, NGOs, and other stakeholders support farmers in scaling up climate-smart adaptation strategies? | |
| Providing technical assistance | 50% |
| Providing financial support | 30% |
| Promoting partnerships and collaborations among stakeholders | 20% |

**Table 5**

*Section 5: Closing*

| Additional Comments |
|---|
| Poor market access, lack of availability of quality inputs, and inadequate infrastructure |

## Thematic Analysis

The survey conducted in the Chakwal District captured information related to demographics, climate change impacts, current adaptation strategies, scaling up climate-smart adaptation strategies, and closing remarks.

## Demographics

The survey respondents were between range of 18 to 65, with an average age of 38. There were slightly more male respondents than female respondents. The education level varied among the respondents, with 35% completing primary education and 15% having no formal education. The majority of the respondents were farmers (50%) and owned landholding between 1-5 acres (40%).

## Climate Change Impacts

Almost all respondents (95%) noticed changes in weather patterns in the past few years, with the majority of them observing changes in rainfall patterns. These changes have had negative impacts on agricultural production for 80% of the respondents, with wheat being the most affected crop.

## Current Adaptation Strategies

The most common climate-smart adaptation strategies implemented by the respondents were crop diversification (40%) and improved water management practices (30%). While the respondents reported that these strategies were somewhat effective in mitigating the bearings of climate change on their agronomic manufacture, only 20% reported that they were highly effective. 40% of the respondents received support from NGOs, while 30% received support from government agencies.

## Scaling up Climate-Smart Adaptation Strategies

The respondents identified a lack of awareness and knowledge among farmers as the biggest challenge to scaling up climate-smart adaptation strategies in the Chakwal District. They suggested promoting awareness and education, providing financial incentives, and strengthening institutional support as opportunities for scaling up. The respondents suggested that the government, NGOs, and other stakeholders could support farmers by providing technical assistance, and financial support, and promoting partnerships and collaborations among stakeholders.

## Closing Remarks

Some respondents shared additional challenges, such as poor market access, lack of availability of quality inputs, and inadequate infrastructure.

Overall, the survey highlights the need for more awareness and education about climate-smart adaptation strategies among farmers in the Chakwal District. The survey also highlights the importance of providing financial and technical

support and strengthening institutional support to scale up climate-smart working strategies.

## Conclusion and Discussion

The survey outcomes from the Chakwal District demonstrate that climate change is already having negative impacts on agricultural production, with the majority of the respondents reporting changes in weather patterns and decreases in crop yields. The findings also reveal that farmers are implementing climate-smart working policies, such as yield diversification and improved water administration, but there is still room for improvement in terms of their effectiveness.

The survey underscores the importance of promoting awareness and education among farmers about climate-smart adaptation strategies, as this was identified as the most significant barrier to scaling up these strategies. Additionally, the survey results suggest that financial and technical support and institutional strengthening are needed to simplify the implementation and scaling up of climate-smart adaptation strategies.

The survey findings have implications for policymakers, NGOs, and additional participants involved in climate change measures, adaptation and agricultural growth in the Chakwal District. The survey underlined the necessity for targeted efforts to increase responsiveness and knowledge about climate-smart adaptation strategies among farmers, as well as the importance of providing financial and technical support and strengthening institutional support to scale up these strategies effectively.

Overall, the survey provides valuable insights into the current state of climate revolution impressions and implementation policies in the Chakwal Area and can inform future interventions and policies aimed at improving resilience to the change of climate in the region.

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