

Climate Change and Adaptation Policies on Pakistan Agriculture

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Climate change (CC) is a worldwide environmental issue affecting all economic sectors, especially agriculture. Pakistan is one of the countries most affected by CC due to the country's vulnerability to catastrophic events and limited ability to adapt. Adaptation has been described as the act of reducing a community's sensitivity to change. Climate adaptation requires reducing sensitivity to existing and future threats of CC.

Keywords: climate change ; crop yield ; adaptation ; farmers ; rural Pakistan

1. Introduction

The effects of global warming jeopardize the achievement of the Sustainable Development Goals (SDGs), which include providing food security for all, promoting sustainable agriculture, helping farmers around the world, and encouraging climate change (CC) action at all levels ^[1]. The CC predictions and increasing climate hazards pose enormous difficulties for agricultural growth in less developed countries ^[2]. Pakistan has been identified as one of the countries most affected by CC due to its limited adaptive capacity and poor infrastructure ^[3]. It is expected that by 2050, the temperature in Pakistan will increase by two to three times, and there will be a significant change in the distribution of rainfall ^[4]. According to the Global Climate Risk Index, Pakistan ranks eighth in the list of countries most affected by CC and hazardous weather events from 1995 to 2014 ^[5]. Over the past two decades, extreme weather and CC have had a major impact on rural life and agricultural production of major crops such as rice, wheat, and sugar cane ^{[6][7]}. The historic floods from 2010 to 2014 and the extreme drought from 1999 to 2003 demonstrated the susceptibility of rural households to CC in Pakistan ^{[2][8]}.

Given that more than 2–3% of Pakistan's population live in remote areas and depend on the agricultural sector for their livelihoods, the resilience of the agricultural sector to CC is one of the most pressing issues for economic growth in the country ^{[8][9]}. CC has a negative impact on local food security in Pakistan, which is mainly dependent on food crops, destructively affecting food production and food costs ^{[10][11][12]}. According to one study, 37% of daily caloric intake in Pakistan comes from wheat, which is cultivated on 8.66 million hectares ^{[2][13]}. Nevertheless, the current average grain yield in the country (2797 kg/ha) is much lower than the world average yield (3268 kg/ha) ^[14]. In Pakistan, farmers harvested only 32% of the potential crop yield ^{[13][15]}. One of the main reasons for the lack of food supply across the country is the huge gap between crop yields and potential yields. For example, Abed et al. ^[2] and Lei et al. ^[16] pointed out that the gap between Pakistan's per capita wheat demand and supply is widening from 2013 to 2050. Uneven agricultural expansion and continued population growth can have severe impacts on local food security and livelihoods ^{[1][17]}. Poor and slow management of CC can make things worse.

A successful farming adaptation level is needed to provide food security and safeguard rustic livelihoods from the negative influences of CC ^{[18][19][20]}. However, an important issue at the local level is that growers, as key stakeholders, must alone bear most of the adaptation load. Under ideal market conditions, farmers may still benefit and receive price increases to cover higher production costs. However, this is not always the case, especially in emerging countries such as Pakistan, where non-market influences (flawed environments) dominate price decisions and farmers may experience higher production costs and poorer returns. Therefore, there is an urgent need to develop public adaptation strategies that consider farmers' goals and adaptation potential. From a policy perspective, it is critical to understand the variables that influence growers' adaptation choices and the impact of their actions on agricultural productivity, which can vary across regions and scales ^{[21][22][23]}. Investigating the dynamics of advantages from continuing private adaption initiatives to CC may also be useful. According to Arshad et al. ^[24] and Abid et al. ^[2], if there are significant short-term adaptation advantages, for instance, this may encourage policymakers to make more efforts to assist growers in the adaptation procedure by granting them access to farm consulting services and assistance from experts.

In the last 10 years, research on CC and agriculture has progressed from research on mitigation ^{[25][26]}. However, in the analyses of the impact and studies on adaptation ^[27], the majority of the literature on agricultural adaptation to CC is from emerging or developed African nations ^[28]. However, there is limited research on how South Asian nations, particularly Pakistan, are adapting to CC, and limited studies such as Abid et al. ^[2] and Esham and Garfoth ^[29], look at CC from the angle of agricultural adaptations to changes in the environment. The majority of research on adaptation has emphasized farmers' responses to shifting climatic circumstances, their adaptation tactics, drivers, and related restrictions for various geographic and socioeconomic contexts. Few studies have focused on this issue at the farm, and empirical assessments of the efficacy of adaptation efforts are difficult to come by ^{[2][30]}. Therefore, more research that economically evaluates existing adaptation processes may be able to show the size of the benefits and make policy recommendations on activities needed to accelerate community adaptation ^{[2][9]}.

2. Rural Farmers' Perceptions for the Impacts of Climate Change and Adaptation Policies on Wheat Productivity

Adaptation has been described as the act of reducing a community's sensitivity to change ^[1]. Climate adaptation requires reducing sensitivity to existing and future threats of CC. An individual's ability to adapt largely determines his vulnerability. While a few people are better equipped than others to respond to a crisis, not every community or family member will be equally affected by a given climate event. Therefore, the adaptation to CC depends on various situations ^[31]. Many studies emphasize the significance of farmer attributes in the adoption of CC adaptation techniques. In an investigation by Deressa et al. ^[32], gender has a favorable impact on growers' adaptation decisions. According to Huffman ^[33], education enhances growers' capability to study and obtain info and expertise regarding CC and adaptation technology. Diendéré et al. ^[34] argue that an increased understanding of climatic events and agricultural technology could help in adaptation. The potential for CC adaptation is also directly connected to household size. For example, Khatri-Chhetri et al. ^[35] determine that bigger household members are more likely to embrace innovative agricultural methods. Aside from these variables, the presence of a climatic shock influences the adoption of CC adaptation techniques ^{[36][37]}. According to the Intergovernmental Panel on CC ^[1], when a producer has previously experienced a temperature-linked climate shock, they are more inclined to apply adaptation approaches. According to Deressa et al. ^[32], decreasing precipitation induces producers to implement soil conservation techniques. Furthermore, some study indicates a beneficial association between the usage of digital technology and growers' CC adaptation methods. According to Diendéré ^[38], innovative technology enables farmers to obtain actual data without incurring trip expenditures and so make suitable modifications.

The use of coping mechanisms is also influenced by farm features. Multiple investigations show that farm size influences the adoption of adaption techniques. According to Perz ^[39], pesticide adopters had a bigger amount of cleared land than non-adopters. Furthermore, some studies contend that economic variables explain the possibility of adopting various agricultural techniques in response to CC ^{[39][40][41]}. Some other authors demonstrated that agricultural funding, particularly transfers of cash, alleviates this cost restriction and hence encourages the adoption of CC adaptation measures ^{[42][43][44]}. Investigations show that, besides economic and farmer features, institutional variables are expected to play a significant influence in CC adaptation. According to Yegbemey et al. ^[45], show that farming groups and relative growers can help adapt to CC adaptation strategies because farmer groups frequently serve as venues for the exchanging of information, individual experiences, and social assistance. Furthermore, Diendéré and Ouédraogo ^[1] approve that interactions with agri-extension services improve the possibility of implementing soil conservation techniques. Agri-extension services educate and advise farmers on optimum agricultural techniques. This literature synthesis emphasizes four kinds of characteristics that are more likely to impact the selection of CC adaptation techniques. There are three categories: institutional considerations, financial factors, and characteristics of the farmer.

Many research investigations have been conducted to evaluate the influence of CC adaptation techniques on family profits and food guarantees. This section provides an overview of available research on the impact of coping methods. A few findings highlight the influence of CC adaptation technology on food insecurity and household income, via econometric and comparative empirical surveys. On the one hand, some research demonstrates that adopting CC adaptation measures improves food security and boosts adopters' income. On the other hand, research indicates that adaption strategies have no beneficial or substantial influence on income or food insecurity. According to several investigations, adopting CC adaptation approaches increases food security and boosts adopters' revenue.

Zakari et al. ^[46] employ matching approaches to indicate that producers' adaptation tactics have a favorable effect on family revenue and food insecurity. Researchers claim that growers who utilized CC adaptation strategies have a higher likelihood of raising their family's profits by 7722 FCFA than growers who do not. Authors found that those who employ adaptation tactics are seven to nine percent more probable to have access to food than people who do not. According to Ndiaye et al. ^[47], implementing CC adaptation techniques raises the average yearly farmers' income by 607,000 to

702,000 FCFA. Furthermore, the authors discover that using adaptation techniques raises the average value of family nutrition utilization by 8–37 points. Farmers that use adaptation choices had greater caloric food ingestion [48]. Berhe et al. [49] suggest that coping measures such as income diversification, and land management methods are among the most significant indicators of family profits. In general, research shows that adopting agricultural methods has a favorable influence on production, household income, and food safety [1][50][51][52]. On the other hand, research indicates that adaption strategies have no beneficial or substantial influence on income or food insecurity. Mulumeoderhwa et al. [53] demonstrate that adaption measures employed by rural producers are unlikely to provide food for families in the long run in the Minembwe mountains of South Kivu. Correspondingly, Pailler et al. [54] indicate that in Tanzania, community-based natural resource management approaches had little effect on the income of households. Berhanu and Beyene [55] also found that the widespread practice of growing food with fences did not substantially contribute to household food security in southern Ethiopia.

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