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REVIEW PAPER

Role of adaptation strategies for climate change and nutrients management tools in Gilgit Baltistan's agriculture

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Abstract

Climate change threatens global food security by raising greenhouse gas emissions, leading to a rise in overall temperatures. Global warming and its negative consequences are increasing in Pakistan and are also visible in Gilgit-Baltistan's ecosystems. Different adaptation strategies greatly impact farmers' lives and provide support to their social, cultural, financial, and human aspects for ensuring sustainable livelihoods. Human and economic assets have significant effects on smallholders' adaptation techniques for their livelihoods. Local farming traditionally has been a substantial share to food production and nutrients in Baltistan's mountainous districts. But macro and micronutrient deficiencies had been reported in most of the soils, which can be furnished through various nutrient control practices. Though few attempts have been made to improve the agriculture of this region, agriculture overall is not in good shape, and it requires attention from Government, NGOs, and academia. The main reason behind this miserable condition is due to no substantial field crop production or soil management advances have been designed and implemented. Conventional methods are still being practiced. Aside from a lack of land, poor seedling, outdated agricultural practices, and inexperienced labor are also major roadblocks to modern agriculture and its sustainability against changing climatic conditions. On a small scale, the application of phosphorus (P) to the soil improved both crop yield and yield-related factors. Better effects have been received from mixed use of seed priming and soil P utility. The foliar utility of macro and micronutrients additionally produced better crop yield and yield components. Similarly, foliar utility of micronutrients (zinc and boron) improved yield over the years.

Keywords: Climate Change, Gilgit-Baltistan, Mitigation strategies, Nutrients management practices, Sustainable agriculture

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Introduction

Global warming poses a danger to the world's food security and nutrition. Because of the greenhouse effect, when greenhouse gas (GHG) emissions rise in the environment, the temperature rises as well. One of the major impacts of climate change on residents of this mountain region is food insecurity. Moreover, climate change has led to more pests, altered weeds, shorter crop durations, and various other changes and fluctuations. Meanwhile, new technologies, methods, seeds, irrigation methods have been introduced in the region. Many towns, communities, and people around the globe are at danger as a result of climate change. Severe weather incidents, dramatic changes in plant and animal ecosystems, and extreme rise in sea level etc. are a few examples that are becoming more common. Climate change and agriculture are intertwined in many ways, because climate change is the primary cause of biotic and abiotic pressures, both of which have negative consequences for a region's agriculture. Additionally, climate change impacts land and agriculture in various ways, such as alterations in annual precipitation, average temperature, heat waves, pests, and bacteria. Though climate change has an impact on all aspects and activities, however, agriculture is often regarded as the most vulnerable industry. Food security and ecosystem resilience are currently the two most pressing global issues. One effective way to address negative impacts on agriculture is through climate-smart farming, aiming to improve crop adaptability before they significantly affect global production (Clark, 2011).

Concerns about the global environment's stability have led to a corresponding rise in food consumption due to the rapid growth of the world's population. Agriculture production is greatly affected by fertility of the soil, pollution in air and water, and accessibility of water. Due to direct and indirect effects of abiotic stresses, severe consequences on plant production are intensifying in response to rapid changes in environmental circumstances. The concentration of CO_2 has risen as a result of persistent deforestation and unwarranted usage of fossil fuels. The greenhouse effect and higher average world temperatures are mostly caused by the release of harmful gases, particularly CO_2. The number of stress episodes, their influence on everyday living, and damage to agricultural crops are used to quantify the consequences of climate change.

The harsh environmental circumstances have had an impact on all living species including plants, animals, fish, and

humans, all over the world (Reynolds, 2010). Everyone is concerned about the threat to the world's climate conditions because agricultural yields might be harmed by changes in many environmental elements, putting food security at risk. The weather has a significant impact on food security and agricultural productivity. The output of main crops has been visibly lowered over the world as temperatures have risen. Current cropping systems with little variety and high input concentrations, as well as unstable production owing to environmental variations in yields, intensify climatic impact (Asseng et al., 2011).

Geography of Pakistan

Pakistan is located at the crossroads of three main Asian regions: the subcontinent to the east and southeast, Central Asia to the north, and the Middle East to the west (Baloch, 2009). The country has a great latitudinal span, ranging from Karakorum and Himalayan Mountains in the north to the Arabian Sea in the south. Furthermore, the Karakorum and Himalayan mountains, as well as a portion of the Hindukush Range, are found in the northern region. Glaciers comprise a substantial portion of the Karakoram Range. As long as the costal border of the country is concerned, it starts along the coast of Makran runs form Indian-border to Karachi city. The coastline extends from the Indus Delta to the Indian border. The Indus River and its tributaries physically pass across the whole nation (Rabbani et al., 2008). The weather in majority of the areas of the Pakistan is dry to semi-arid, with high climate variability both spatially and temporally. However, above 31°N, parts in the northern half of the country are semi-arid to humid, with a sub-humid belt extending along ranges southern of mountains. The southern part of the country mostly experiences arid conditions (Wassman et al., 2009).

Geography of Gilgit-Baltistan

Since 1947, Gilgit-Baltistan has been administered by Pakistan, and in year 2009, it was granted self-government. Gilgit-Baltistan is divided into ten districts and three divisions. The Baltistan Division includes the four districts of Skardu, Kharmang, Shigar, and Ghanche; the Gilgit Division includes the four districts of Gilgit Ghizer, Hunza, and Nagar, which were created out of the Gilgit District; and the Diamer Division includes Chilas and Astore, which was carved out of the Diamer District earlier. Gilgit and Skardu are the primary political centers of the region (Khan, 2012).

Overview of climate change situation in Pakistan

Pakistan's air temperature trends align with global patterns. According to recent data from the Meteorological Department of Pakistan, between 1960 and 2010, the average temperature in Pakistan increased by 0.46 °C at a statistically significant rate of 0.098 °C per decade. The monsoon rainfall, however, only increased by 23 mm over the period 1901-2010, which is not statistically significant. The data, analyzed in 10-year moving averages, reveals inter-decadal variability with cycles of 20-30 years. Rainfall exhibited a declining trend from the second to the fifth decade of the 20th century, followed by an upward trend until 1962. Subsequently, there was a decline for the next decade, followed by modest differences until a downward trend re-emerged in 1997 (Rasul & Ahmed, 2012).

Future situation of climate change in Pakistan

Weather agencies, both national and international, report significant temperature shifts in the region. The research reveals that both maximum and minimum temperatures are increasing. There is a notable increase in the proportion of the region experiencing a significant change in low temperatures (5 °C) compared to the percentage of the region with a significant change in high temperatures. Additionally, predictions indicate that in summers, the daily minimum temperature will rise faster than the daily maximum temperature, while in winter the shift in maximum temperature will be significant.

Implications of climate change

Climate change presents not only environmental challenges but also economic and developmental hurdles. Recent research emphasizes the importance of gender differences in the success of any program aimed at addressing climate change. Unequal power dynamics between males and females in our society play a significant role. Rural women, who often depend on climate-sensitive resources for their lives and livelihoods, face challenges in having equal authority, decision-making capacity, and resources to adapt to climate change.

Climate change and agriculture

The interaction between climate and agriculture is complicated. They mutually influence each other, creating a problematic cycle that worsens the situation. Climate change has a definite impact on agriculture. Additionally, the pressure on agriculture to enhance yields, coupled with the adoption of new technologies, leads to an increase in greenhouse gases (GHG). These gases, in turn, contribute to the phenomenon of climate change. This section explores the complexities of this relationship.

Food security and agriculture

Various global issues and concerns including development, food security and climate change are directly linked to agriculture. No humanitarian aim is more important than

feeding a world population that is expected to exceed 9 billion by the middle of the current century. By the year 2050, meeting rising food demands due to rising population and income levels would almost certainly necessitate a 51 percent increase in overall food output. In this connection, for human survival, agriculture is the most important sector (Hoffmann, 2011). Agriculture faces ongoing pressure to grow and become more intense due to increasing demands for resources caused by population growth and a shift toward a higher standard of living. While public and international agencies heavily invest in enhancing global agricultural production, there is a lack of sufficient focus on making agriculture ecologically sustainable. Creating environmentally friendly and sustainable agricultural practices is essential for long-term environmental harmony (Hertel & Rosch, 2010). Seventy percent of the freshwater consumed by people is used in agriculture, primarily from non-renewable sources. Over three-fifths of the earth's surface utilized by humans is dedicated to pastures and crops. The water utilized in agriculture makes up about seventy percent of the total water consumption by humans (Foley et al., 2011). Agriculture is the main reason for species extinction and changes in natural habitats globally. It is also a major contributor to pollution from toxins and nutrients, as well as being susceptible to attacks by harmful species (Sekercioglu, 2012).

Agriculture as a cause of greenhouse gases emissions

The production of biofuels and food contributes to 20 % to 25 % of the world's total greenhouse gas (GHG) emissions, primarily due to changes in land use for agriculture. Despite being substantial and comparable to emissions from the transportation sector, the potential of agriculture to reduce GHGs has been overlooked in global climate discussions. Making progress in supporting the agricultural industry, especially farmers, is crucial for meeting the needs of a growing global population. Besides increasing yield, key concerns should focus on reducing GHG emissions and enhancing soil fertility (Johnson et al., 2007).

Mitigation

Given the significance of food security, efforts to decrease emissions in the farming sector should prioritize this goal rather than focusing solely on emissions per unit of land or the total emissions of a region. Many mitigation possibilities in agriculture align with enhanced productivity. Concentrating on reducing emissions intensity enables the alignment of environmental and human rights objectives (Bandyopadhyay, 2011).

Following is the list of possible measures to reduce GHG emission:

- Reduction in direct GHG emission
- Carbon sequestration
- Reduction in food waste
- Emission reduction in forests
- Expanding biofuels use
- Reduction of drain form terrestrial wetland (Bandyopadhyay, 2011).

The Himalaya-Karakorum-Hindu Kush highlands are vulnerable to the effects of climate change as well. The average temperature in these ranges has increased at a rate of 0.99 °C each decade during the last 100 years (Singh et al., 2011). According to climate forecasts, temperatures would rise one to two degrees Celsius by the half of the twenty-first century, and rainfall pattern will shift, with prolonged and more irregular monsoons but less often but far more heavy rains (Bhutyani, 2007). Climate change will not only decrease freshwater supply to approximately 2.14 billion people both upstream and downstream, as these mountain ranges are important sources of freshwater, but it will also affect people's lives, agricultural production, biodiversity (including plant life cycles), population, and ecosystems (Stern & Stem, 2007). Climate change will not only decrease freshwater supply to approximately 2.14 billion people both upstream and downstream, as these mountain ranges are important sources of freshwater, but it will also affect people's lives, agricultural production, biodiversity (including plant life cycles), population, and ecosystems (Namgyel, 2008). Similar findings have been observed in mountain regions of GB (Gilgit-Baltistan). The orographic nature of the highlands, creating micro-climatic variations along the mountain slope, introduces more uncertainty when trying to generalize climate predictions and potential impacts of climate change in these areas (Hussain et al., 2010).

Except for a few areas in these mountain regions, there is a notable lack of historical climate data. This limits our understanding of climate change and its feedback systems, making it challenging to validate climate change models and predict future scenarios accurately. In Gilgit-Baltistan, there are only nine meteorological observatories, resulting in limited climatic data. The impact of climate change may vary due to the considerable altitudinal variation in the vulnerable mountainous terrain (Rasul & Ahmad., 2012). The Ghizer area in Gilgit-Baltistan is facing a growing number of climate change-related natural catastrophes. GB faces threats from various catastrophic events, including heavy rains, Glacial Lake Outburst Floods (GLOFS), rockfalls, avalanches, landslides, and earthquakes. These lakes, Glaciers, and Glacier’s lakes in the high elevation highland zones are major sources of these disasters. As a consequence of rainstorms, rain bursts, and melting snow, these sources cause floods. As the area becomes more sensitive to climate-related natural

catastrophes, local folk's subsistence assets are more at danger (Muhammad, 2011).

Socio-economic impact of climate change on residents of Gilgit-Baltistan

The sensitivity of socio-ecological systems to the negative effects of climate change is referred to as climate change vulnerability. These vulnerabilities have many layers, dimensions, and faces, and it is impacted by natural, socioeconomic, and political variables that limit a community's ability to adapt to the negative effects of climate and environmental change (Preston & Stafford-Smith, 2009). Karakoram's poor communities are extremely vulnerable. They rely heavily on land, resources, and environmental services. These elements are crucial for their socioeconomic sustainability and stability. However, they have a very limited and risky natural productive capacity (National Research Council, 2012). Moreover, ongoing disparities related to gender, race, economic class, religion, and political exclusion, along with increasing sectarian tensions, have fueled the region's sectarian conflict (Bansal, 2008). Climate change and unpredictability, along with severe events, negatively affect communities that rely on resources, impacting both property and incomes. In rural areas, various social and economic factors, including climate change, influence the choice of coping and adaptation strategies (Holmelin, 2010). Farmers must first assess environmental and climatic variation in order to establish methods that might potentially lessen the risk they face. The region's rough geography, as well as snowfall and melting glaciers in the mountainous regions and regular rainfall, have increased the dangers. Due to global warming, earthquakes, flooding, rockslides, or even other occurrences, settlements in the higher (one crop) zones are separated for 2 to 3 months annually (Aggarwal, 2008).

Economic impact of climate smart agriculture strategies

In Hunza and Yasin (part of Ghizer district), there is a significant labor mobility, and they don't heavily rely on subsistence agriculture. Yasin valley faces more flood issues compared to Hunza. Hunza experiences frequent GLOFs, but landslides are a common problem, as seen with the formation of Attabad Lake due to a large landslide in the Gojal region on the Hunza River (Korup & Tweed, 2007). A number of villages including, houses, farming land, and infrastructure are all drowned under the lake. Environmental issues deterioration in the highlands has begun having significant consequences. Mountain villages are witnessing extraordinary climate occurrences, such as longer and milder winters, unseasonably warm summers, and exceptional snowfall buildup (Wang, 2012). Asia's Himalayan Mountain (AHM) are particularly vulnerable to natural disasters since most of the territory relies on rainfall patterns and glacier drainage for water, and many populations lack the capacity to cope with the impact of quickly changing climate. AHM are also under risk if the incidence and severity of extreme climate rise. Varying meteorological impacts, such as summertime monsoon season and wintertime northwestern shocks, as well as wildly different surface features amongst mountainous regions, necessitate a wide range of climate mitigation actions (Lindner, 2010). The severity of hazards is causing physical and economic damage to the local population, leading to economic stagnation in the region. The 2010 floods and subsequent flash floods have had a significant impact on mountain communities. A study suggests that the region is still at risk due to several subsurface glacial lakes in various valleys that could break, causing havoc. Recent examples include the Hassanabad Hunza GLOF outbreak, Passu GLOF, Darmendar flash floods, and others, which have had substantial economic and social impacts on the residents of the region (Azhar-Hewitt & Hewitt, 2012).

Nutrients management practices

Nutrients management practices play a significant role in Gilgit Baltistan's sustainable agriculture (Singh, 2011). Plants require specific nutrients in precise quantities and forms at specific times to foster their growth and development. The roles of both macro and micronutrients are vital in crop nutrition and significantly impact achieving higher yields (Arif et al., 2006). Unfortunately, many of our soils suffer from deficiencies in these nutrients (Jahiruddin et al., 1995), necessitating proper management of crop nutrients. Various methods can be employed to provide these nutrients, including the application of organic matter like farmyard manure (FYM) and fertilizers to the soil, nutrient seed priming, and the foliar application of nutrients. This involves recycling nutrients from crop residues, manure, and other sources back into the soil. It can reduce the need for external inputs (Nazir et al., 2021). Preventing soil erosion is also crucial for nutrient management. Erosion not only results in soil loss but also carries away valuable nutrients. Practices such as contour farming, terracing, and agroforestry can help control erosion (FAO, 2020). Educating farmers about sustainable nutrient management practices is necessary. Extension services and farmer training programs can help disseminate knowledge about best practices (Gebska et al., 2020). The government of Gilgit Baltistan should support sustainable agriculture through policies that promote responsible nutrient management, provide subsidies for organic inputs, and encourage environmentally friendly practices (Mughal, 2021).

Adaption strategies to climate change in Gilgit-Baltistan

Climate-change-related dangers cannot be eliminated by a natural process of progressive adaptation at the rate and scale envisaged in the broader Himalayas. People must work hard to avoid unpleasant outcomes in the future. Residents in hilly

locations can cope with natural threats by applying traditional ecological knowledge and rituals (Byg & Salick, 2009). Mitigation efforts such as conservation agriculture, covering harvests, relocation to less climate susceptible locations, and the use of weather resilient cultivars have little effect. Among these mitigation options, the most feasible alternative is conservation agriculture, as farmers must make the most of their available resources.

Small farmers in poor nations have begun to explore low-cost ways to deal with the negative effects of climate change in recent times. Poor small farmers in rural settings, on the other hand, are particularly susceptible due to insufficient predicted future risk management and lack of abilities to absorb shock the risks experienced (Azam & Imai, 2012). Poor farm households often seek temporary and long-term relocation to mitigate for income losses caused by climate fluctuations, depending on their capacities. Migration is used as a primary reaction to environmental stress, both as a predicted future risk reduction approach for dealing with unpredictable agricultural output and as a coping technique in the aftermath of environmental shocks (Schiling, 2012). The predicted future risk called Ex-ante coping mechanisms are placed before a shock occurs in order to lessen the impact of the shock. In the case of agriculture, example ex-ante can be to introduce novel Agri-Tech, to in place new irrigation techniques, modification / diversify livelihood etc. While ex-post coping methods are those that are undertaken after the shocks to deal with the damage done by the shocks, such as relocation, lending, loans, government help, and so on. Migration and armed conflict are induced by climate change, and the choice to migrate is based on mitigation capacity and the severity of crises (Fatima & Safdar, 2011).

The increase in temperature has a main adverse effect on crops productivity, but a rise in precipitation was expected to improve income; nevertheless, the total negative impact of temperature changes is more than the beneficial impact of rainfall patterns (Shakoor et al., 2011). Furthermore, new farming methods, such as novel irrigation techniques, better farm management solutions, and modified farming trends, would be acceptable adaptations for the fundamental transformation of the dry region's farming industry. In recent years, Pakistan has seen massive flooding, droughts, and storms that have perished and dislocated millions, ruined livelihoods, and devastated facilities. Climate change increases the likelihood that that and other natural catastrophes may become more frequent and severe in the upcoming years, a sobering warning that Pakistan is indeed one of the nation’s most susceptible to the climate crisis (Ahmed et al., 2012).

Role of local farming and NGOs for adaptation of new technologies to ensure sustainability

Local farming has traditionally been a substantial share to food production and nutrients in Pakistan's mountainous districts. Contributions of food from local farming have decreased dramatically over time (Sultana et al., 2009). Food insecurity is still a big issue in the HKH, where 75% of the populace is food insecure and almost 50% is malnourished (Vaidya, 2012). Local populations in research areas estimated that local farming presently supplies roughly 30-40% of yearly nutritional needs (Armstrong, 2010). This suggests that local people's reliance on imported food has risen, resulting in a decrease in agronomic and nutritional diversity, as previously found in research on other highland locations (Rasul, 2012). Conventional food plants, such as barley, millets, and legumes, are vanishing from farming production at an alarming rate (Harrop, 2009). Mountain environments are difficult to live in, and mountain people have a longstanding experience of adjusting to harsh conditions. Conventional mitigation measures, on the other hand, are frequently insufficient to deal with current environmental and social changes, which have significantly exacerbated the obstacles faced by mountain people in ensuring their subsistence (Merino, 2010).

Due to extreme climatic circumstances, the accessibility of farmland has changed dramatically in the area. Conventional methods have still acceptable results in the area when it comes to making decisions on water sources. In the last decades, global warming has brought new illnesses to plants and livestock, and over 78 percent of communities have been afflicted by these illnesses, making them susceptible. Pests have attacked crops and cattle in over 80 % of households in the region, and 59 percent believe that new health issues have emerged in the region as a result of an unbalanced diet. Food insecurity has decreased over time, and global warming has resulted in 87 percent of households receiving reduced crop yield. Only 3 months' worth of food was left (Kreutzmann, 2012).

The AKRS'P and the Agricultural Department have provided a wide range of seeds and crops. Because approximately sixty percent of people do not engage in off-farm occupations as their primary source of income is farming. However, farm dependency is decreasing, and individuals are increasingly turning to the service industry. They presented new crops for high and excellent output, and the AKRS'P and the Agricultural Department assist farmers in developing cherries and pear plant kinds. Vaccines are used to treat cattle diseases, whereas fertilizer, insecticides, and spraying are the most effective ways to treat insects. New seeds and farming technologies introduced by the AKRSP substantially increased yield / productivity in Minapin and other villages of the Nagar District since 1980s. It includes chemical fertilizer, new varieties of vegetable and wheat seeds. Furthermore, new machinery, e.g. tractor and other farming equipment as introduced in the region. This cooperation and adaptation were extended to horticulture as well. New species of apricot, apples, cherries were introduced which increased productivity and new opportunities to increase income. New seeds of potatoes were also successful. It not only increases income of

the valley, it also increases nutritional requirements of the local population (Rosen et al., 2012).

The second factor which accelerated the adaptation of new seeds and machinery is linked to market forces and political events. For example, the wheat subsidy given to region by the then Prime Minister Mr. Zulfiqar Ali Bhutto in 1970s, allowed local communities to replace wheat with other crops especially, potatoes. In this region the weather is suitable for the potatoes. A company called J-Brothers, from Sindh reached the community and distributed fresh potato varieties, instructed local growers, provided fertilizer, and purchased their potato production on a contractual basis (Huettman, 2012). Third factor is the development of the Karakoram Highway, in especially, must be viewed as an infrastructure prerequisite for increased trade between this mountainous area and the rest of Pakistan. Substantial changes to this highway also contributed to Nagar's massive rise in cherry yield, as mobility time is critical for this fragile fruit: cherries are cautiously packed in small containers and transferred immediately to marketplace in cities, where they would be typically sold the day after (Rosen et al., 2012). Aside from the seeming modernization of food land, other agricultural methods have altered dramatically. The fall in livestock farming recorded in all regions of GB is by far the most noticeable trend among them (Kreuttzman, 2012).

Modern agriculture technologies are being used in various parts of Gilgit-Baltistan. For example, some farmers in upper Hunza are using plastic tunnels to grow in harsh weather, even in winters (Hussain et al., 2021). Economic Transformation Initiative (ETI), cofounded by IFAD, is working towards agricultural value-chain expansion to promote area economic growth. Knowing the necessity, ETI Gilgit-Baltistan took the initiative and brought the Vertical Agricultural idea of agriculture to the region, which entails modern agricultural practices that need less space and provide higher yields (Muhammad et al., 2011). Vertical farming has produced incredible results. It has increased the yields and helps to grow vegetables in off-seasons and even in harsh winters. ETI assists farmers with technical help by engaging experts for nurseries growing nursery transplanting, spraying, and vegetables packing (Appeaning Addo, 2010). Irrigation system has been improved by the Government and NGOs. IFAD is currently working to increase the farmland in most of the Districts in Giligit-Balistan. It is improving irrigation systems among other techniques/ Methods to improve agriculture in the region. Barjungle water channel project was initiated by IFAD to improve irrigation system of the valley. Large projects include Sadpara lake project, supported by the US Government helped minimize water losses by around sixty percent putting more area under cultivation to boost agricultural growth in the area and increasing income and yield for over eight thousand growers (Alam et al., 2012). ICT (Information and Communication Technologies) is another field which has a great impact on agriculture. Recently, GB has started enjoying the benefits of ICT in all fields including agriculture. Though internet speed and coverage are the main issues, it is improving. It is expected that it will have a positive impact on agricultural productivity as well (Butz & Cook, 2011).

Conclusion and future prospects

As the world's population grows, so does the strain on agriculture to provide global food safety, which is exacerbated by climate change. Despite the uncertainty surrounding the global weather situation and its potential consequences, several studies have concluded that global warming would reduce agricultural production in the next decades. Highlands house nearly 17% of the global population, the majority of whom are impoverished and disadvantaged. Eighty percent of those living in poverty, and an approximate 270 million people are vulnerable to food insecurity, with almost half of them suffering from chronic hunger. The effects of climate change are anticipated to worsen this susceptibility. Though many efforts have been made to improve agriculture to make it more sustainable, it is a dreadful situation that has to be addressed right now. Cropping patterns are rudimentary in comparison to local cultivars, and agricultural crops are raised using inadequate sustainable farming approaches. To make agriculture in Gilgit-Baltistan more sustainable and resilient, we need a comprehensive approach. Promoting sustainable farming, managing nutrients for soil health, researching climate-resilient crops, and modernizing agriculture are crucial. Water should be managed efficiently, engaging communities in climate discussions and educational programs. Government and NGO support is needed, along with continuous research and disaster preparedness. Advocacy for policies supporting sustainability and collaboration among stakeholders is essential for a resilient agriculture system in Gilgit-Baltistan.

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