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Climate Change and Wheat Rust Diseases: A Case Study of Kallar Syedan

Abstract

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Keywords: Climate Change, Wheat Rust, Wheat Production

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Title

Climate Change and Wheat Rust Diseases: A Case Study of Kallar Syedan

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Contents

Abstract

This study, "Climate Change and Wheat Rust Diseases: A study in Kallar Syedan, District Rawalpindi," aims to look at farmers' perceptions of climate change and wheat rust diseases on crop productivity. Qualitative methods were used in this research, based on data gathered through interview guides. The methodology involves an in-depth study of farmers' experiences and observations in Choa Khalsa, a village of Kallar Syedan, to understand the observed changes by farmers in temperature, rainfall, and wind patterns and their outcomes on wheat rust diseases and crop productivity. This method allows a detailed understanding of the farmers' views on the challenges faced by climate change, the changes in wheat rust diseases, and the effects on crop productivity.

Keywords:

Climate Change, Wheat Rust, Wheat Production

Introduction

Climate change really impacts global food security by minimizing crop production and increasing plant diseases (Dixon, 2012). Anthropological research is crucial to understanding the socio-cultural and political factors of this international issue (Magistro & Roncoli, 2001). Due to the large population and environmental risks, South Asia is highly sensitive to climate change, which impacts its agriculture and small farmers (Sivakumar & Stefanski, 2011). Pakistan is one country where this is a huge concern. Farming is a big part of Pakistan's economy, and many people there depend on growing crops for a living. Studies in Pakistan's Punjab show that farmers are facing increased climate risks. Poverty and poor infrastructure have limited their ability to adapt; improving supportive services is key to building recovery (Abid et al., 2016). Therefore, combining global and local understanding, socio-economic factors are crucial

for developing new adaptable crops and ensuring food security in sensitive regions like South Asia and Pakistan (Newton et al., 2011). Climate change and too much fertilizer can harm sustainable wheat production by influencing fungal diseases like rust (Diakite et al., 2023). Rising temperatures, changed understanding about climate/weather, and higher CO_2 levels due to climate change are making wheat diseases worse. For example, a 1°C temperature increase can lower global wheat production by 6%. High temperatures (25-30°C) can worsen fungal stem rust, while increased CO_2 improves disease severity and makes wheat easily affected, leading to more serious overall disease. Climate-related factors like strong winds can also make it easier for the quick spread of rust fungi (Diakite et al., 2023). Too much fertilizer, especially certain forms like urea, increases the seriousness of diseases such as stripe rust. This is due to increased canopy (the upper layer of branches and leaves in a forest) density, which creates supportive weather for fungi, and higher fertilizer materials in plant tissues, which can cause diseases (Diakite et al., 2023). Reduction strategies include improving fertilizer amount, using specific fertilizer forms, including silicate fertilizers, implementing long crop rotations, developing strong wheat types, adjusting sowing dates, and improving irrigation systems (Diakite et al., 2023). Wheat rust is a fungal disease that affects wheat crops, causing significant yield losses.

Types of Wheat Rust Diseases

There are three main rust diseases that impact wheat: stripe rust (yellow rust), stem rust (black rust), and leaf rust (brown rust).

- Leaf Rust (Brown Rust)The most common wheat rust, Leaf Rust, mainly attacks the leaves of the wheat plant. Temperatures between 10◦ and 30 ◦ °C are ideal for it. Usually, it causes small losses (less than 10% of the crop). But if there's a bad epidemic, it can damage yields by more than 30%, making the grains dry up.
- Stem Rust (black rust). This type is very dangerous and can destroy a whole crop. It likes warm, wet weather. It grows in temperatures between 15◦ and 35 ◦°C. If the wheat is not inflexible, it can entirely destroy the crop. If conditions are favorable, it can result in a 50% loss in just one month.
- Stripe Rust (yellow rust)Stripe Rust is a disease that is common in cooler climates (2 to 15 ◦°C) and is often observed in higher altitudes or northern regions. It can cause large losses that, in severe cases, can result in the loss of the entire crop (Singh, Huerta-Espino, & Roelfs, 2004).

Problem Statement

Wheat rust disease is a big problem for growing wheat worldwide, costing a lot of money each year. Climate change makes this worse by contributing to the spread of the disease faster and making it harder for wheat to grow. Farmers know about these problems, but they don't always have the tools or support they need to cope. The main issue is that farmers and the systems around them aren't ready to handle these challenges, which puts our food supply at risk.

Research Objectives

1. To understand farmers' observations on wheat rust disease patterns and climate change.
2. To explore farmers' strategies for managing wheat rust diseases under climate change.
3. To analyze the effectiveness and challenges of these strategies.

Research Questions

1. How do farmers perceive changes in the patterns and severity of wheat rust diseases in relation to climate change?
2. What strategies are farmers currently using to manage wheat rust diseases under climate change?
3. How effective do farmers consider their management strategies for wheat rust diseases in the context of climate change?

Significance of the Study

This study is important because Kallar Syedan is a wheat-growing area, which is experiencing climate changes like temperature changes and changes in rainfall that support the spread of wheat rust diseases, such as leaf rust. These diseases reduce wheat production and risk farmers' incomes and local food security. Since many farmers in Kallar

Syedan depend on wheat as a basic crop, understanding how climate change affects the rust epidemic will help develop better management strategies, including using rust-resistant wheat types and changing farming practices. This research provides valuable local insights to support farmers, guide policymakers, and improve wheat production adaptability under changing climate conditions.

Review of Literature

Climate change is causing a big challenge to the agricultural sector globally, especially in developing countries, by inducing unexpected and extreme rainfall patterns that impact crop outcomes, food security, and farmer livelihoods (Triticum aestivum L). Wheat is an important basic crop worldwide, important for Pakistan's food security, and accounts for approximately 21% of the world's food supply and one-fifth of the human diet. Despite its importance, wheat production is increasing at a rate (0.9% annually) below the required 1.5% to meet projected global demand by 2050, highlighting an important need for sustainable methods to improve production. Wheat farming faces many challenges, both biotic(living) and abiotic(non-living), with heat stress being an important limiting factor in South Asia and other temperate zones. Temperatures going beyond the ideal range can permanently harm wheat crops, leading to production losses, with some research indicating a 3-5% reduction in crop output for every year (Sajjad et al., 2024).

Studies show that climate change might change plant diseases. Higher temperatures and more CO2 can affect both the plant and the germs that cause disease. Climate change makes farming more difficult, not just by directly affecting what we can grow, but also by changing plant diseases (Newton et al., 2011). Addressing climate change's complex effects on agricultural systems and food security, we need to bring together knowledge from different fields, including anthropology, along with the science of nature and agricultural sciences. Anthropology helps us understand that these changes are not just about biology; they're also about how societies and cultures work (Torrey, 1983). Anthropology looks at how people adapt and how their societies work, which is important for understanding how communities deal with climate change affecting their farms. Plant diseases require serious attention, which already cause big losses and are expected to get worse with climate change (Yañez-Lopez et al., 2012; Dixon, 2012; Coakley et al., 1999). To find better solutions, we need to use local farming knowledge and traditional practices, as well as understanding both the biological and socio-cultural factors to address these challenges (Newton et al., 2011; Torrey, 1983). Agriculture is one of the most important sectors affected by climate change, with changed rainfall patterns, rising temperatures, shifting sowing and harvesting dates, and effects on water availability and water loss (Janjua et al., 2010). While rising CO_2 levels can benefit crop plants such as wheat by improving productivity and water usage efficiency, higher temperatures may significantly reduce yields by speeding the loss of water and shortening the growth period. According to drought research, global warming might produce severe drought in 60% of wheat-growing areas worldwide, with a 2°C temperature change potentially resulting in severe water shortages within 20-30 years, hurting yield particularly during milk production and harvesting periods. Beyond productivity, climate change makes wheat more vulnerable to a variety of illnesses (Janjua et al., 2010).

Wheat stem rust disease is also a big problem for wheat worldwide, including in Tanzania. A study there showed that stem rust is more serious in warmer, humid areas (high moisture in the air)(like northern Tanzania) because these conditions help the disease grow. Older types of wheat are more likely to get sick than modern, stronger types, with the good quality showing good resistance (Aloyce,2025). As temperatures rise and rain patterns change, stem rust is expected to become even more common and serious by mid-century (Aloyce,2025). Scientists have been looking into how our changing climate (like hotter temperatures or different rain patterns) affects wheat, especially when it comes to diseases. It's a difficult problem, and what they've found isn't always simple. For example, some studies suggest that a disease called Fusarium head blight (FHB)(fungle disease) might get worse in the UK by the middle of this century (Madgwick, West, & Fitt, 2011; West et al., 2012a; West et al., 2012b). But then, other research says that a different disease, Septoria tritici blotch (STB)(also fungle disease) might in fact become less severe in France later in the century (Gouache et al., 2011; Gouache et al., 2012).

This shows that climate change won't always make things worse for wheat diseases; sometimes, depending on where the wheat is and exactly how the climate changes, it could even help the plants stay healthier (Juroszek & von Tiedemann, 2011; Siebold & von Tiedemann, 2012).

It's difficult to assume what diseases will do far into the future because scientists use different computer models and ways to guess what the climate will be like, which can lead to different results Because of this, it's hard to correctly say how much wheat we might lose due to climate change, so more studies are definitely needed (Juroszek & von Tiedemann, 2011). For a long time, when people talked about how climate change affects crops, they mostly focused on how much wheat would grow or not grow because of temperature or CO_2 changes. They often didn't pay enough attention to how diseases would also change things (Chakraborty & Newton, 2011; Savary, Ficke, & Aubertot, 2011). But a big study by Lobell and colleagues in 2011 found that from 1980 to 2008, global wheat production actually dropped by about 5.5% because temperatures got hotter. This means that the warmer weather killed off any good things that came from better farming methods or more CO_2 in the air. So, protecting wheat from climate change, especially from diseases, is now a really important global issue (Chakraborty & Newton, 2011; Ewert, 2012; Ortiz et al., 2008; Rosenzweig et al., 2001; United Nations, 2011; White et al., 2011). Wheat is especially at risk in places where temperatures are rising or there's less rain, like parts of South Asia (Lal et al., 1998). For example, a study about northwestern India predicted that severe water shortages and heat would really hurt wheat growth there (Lal et al., 1998). On the other side, climate change might actually open up new areas for growing wheat where it's currently too cold, assuming farmers can adapt (Ceglar & Kajfez-Bogataj, 2012; Ewert et al., 1999; Fuhrer, 2006; Miglietta et al., 1995; Toure et al., 1995).

The way climate change affects how much wheat grows is very complex. We don't fully understand how things like temperature, humidity, and CO_2 all work together (White et al., 2011). There are still a lot of unknown outcomes about how these changes will impact crops (Gornall et al., 2010; White et al., 2011). And when you add plant diseases into the mix, it can either make things much worse or, in some unusual cases, surprisingly better for food production (Juroszek & von Tiedemann, 2011).

Fungal diseases are a huge problem for wheat farmers worldwide, causing big losses (Oerke, 2006). These include common ones like stem rust, leaf rust, and stripe rust. There are also other fungi that live on remaining plant material, like those causing tan spot, Septoria tritici leaf blotch, Septoria nodorum blotch, spot blotch, and various types of Fusarium head blight(FHB)(fungal disease), all leading to significant damage (Duveiller et al., 2007).

Changes in climate, like different temperatures and rainfall, can affect wheat diseases in many ways. They can change when diseases appear during the growing season, change how many disease-causing organisms are around, and even cause diseases to spread to new areas or disappear from old ones (Baker et al., 2000; Boland et al., 2004; Chakraborty & Newton, 2011; Chakraborty et al., 2000). Climate change and fertilizer management are important factors that have an effect on wheat fungal diseases. Combined methods or strategies are important to address these challenges for sustainable wheat production (Diakite et al., 2023). To deal with this, farmers need to use different farming methods, plant disease-resistant wheat, and invest more in research and policies to protect food supplies (Aloyce, 2025).

Materials and Methods:

Locale

The locale of my study was Choa Khalsa, a village of Kallar Syedan Tehsil, District Rawalpindi, in which I am interested in conducting data collection for my research. The area features fertile agricultural plains and hilly regions. Agriculture is a significant part of the local economy, with crops like wheat, maize, and vegetables being commonly grown.

Population Figures**:** As of the 2017 census, the total population of Kallar Syedan Tehsil was 217,273.

Data Collection

The research used in-depth interviews to gain a deeper understanding of the topic. There were open-ended questions, and data was collected

through interviews and with the help of voice recorders.

Methodology

The methodology used in this study was an exploratory research methodology focused mainly on gathering farmers' views on climate change and wheat rust diseases in Choa Khalsa, a village of Tehsil Kallar Syedan. This method was suitable for gaining a deeper understanding of the farmers' experiences and observations within the local context.

Method

In this study, I used In-depth interviews to collect information from farmers. There were open-ended questions to know about the different views and experiences of the respondents.

Tool

An interview guide was developed to ensure consistency across interviews while allowing for flexibility to explore developing ideas. The guide will include open-ended questions.

Sample

For this study, the sample size was 30 participants (farmers).

Result and Analysis

A total of 30 wheat farmers from the Choa Khalsa village in Kalar Syeda were interviewed, with farming experience ranging from 10 to over 30 years. Most farmers reported changes in their farming practices over the years, primarily due to changes in weather patterns, an increase in wheat diseases, and technological innovation. All participants said that climate change is impacting wheat production, with increased rainfall and temperature changes.

Farmers observed many cases of wheat rust diseases, the most common of which is leaf rust. Rust diseases were found to have increased in years with above-average rainfall. The majority of farmers attributed the increased incidence and severity of rust illnesses to climate change, specifically wetter and wetter situations.

Farmers mostly used sprays to treat wheat rust. Traditional or indigenous disease management methods were rarely used. Conversation with other farmers was the primary source of information about new farming techniques. The ways farmers manage these problems are not enough, so they need more help, better information, and new methods to protect their crops.

Conclusion

This study provides useful insights into the complex relationship between climate change and wheat rust diseases from the perspective of farmers. The findings indicate that climate change has notably influenced the occurrence and distribution of wheat rust, thereby affecting wheat production and farmers' livelihoods. Due to climate change, rust diseases spread faster and survive in some places, while also directly harming wheat crops with extreme weather. This puts our food supply at risk, especially in farming countries like Pakistan. Farmers are facing difficulties due to environmental uncertainties and resource limitations.

Recommendation

It is recommended that Policymakers and agricultural services should prioritize developing and sharing climate-adapted wheat rust management strategies with farmers. This includes providing timely information on disease patterns and promoting interconnected practices that combine traditional knowledge with modern techniques. Awareness programs should be arranged for farmers to prepare them with skills to adapt to changes in climate conditions. Increasing investment in research on climate change and the connection to wheat rust is also important. Collaboration between farmers, researchers, and government agencies is important to ensure the sustainable production of wheat in climate change conditions. To support farmers, we need to provide them with better advice, new technologies, and essential resources like water-saving methods and high-quality seeds.

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