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ASSESSING THE EFFECTS OF CLIMATE CHANGE ON CEREAL CROP PRODUCTION IN PAKISTAN

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ABSTRACT

This paper endeavors at analyzing the effect of climate change on cereal crop production in Pakistan in 1990-2024 with a particular focus on the contribution of temperature, precipitation, CO_2 emissions and extreme flood events. Wheat is the staple cereal crop and is sensitive to climate extremes and forms a vital part of the country's food security. The study uses Auto-Regressive Distributed Lag (ARDL) to analyze not only the long run relationships but also the short run relationships between climate variables and wheat yield. The results show that there is a high long-term cointegration relationship between the variables of climate and wheat production. The results indicate that the effect of flood event on wheat production is quite negative, whereas the CO_2 emissions have positive fertilization effect in the short term. The positive effect is, however, not the whole story and does not outweigh the overall negative effects of climate change. The study concludes that climate change, especially in the form of extreme weather shocks, is a big challenge for wheat productivity in Pakistan. It calls for specific policy interventions to boost climate resilience, strengthen water management systems, and increase the support for farmers to safeguard food security and rural livelihoods in a climate-driven environment of greater adversity.

Keywords: *Climate Change, Cereal Crops Production, Heat-Precipitation-CO2 Emissions, Food Policy, Times Series Analysis, Pakistan***,** *JEL Codes: Q54, Q10, Q18, C32, O13*

INTRODUCTION

The global phenomenon of climate change has become an urgent subject of academic policy and public discourse especially in regions with high population densities and agriculture dependence (IPCC,2022). Punjab, the country's breadbasket, is producing the majority of its cereal crops such as wheat, rice and maize (Rauf, et al, 2021 and Ali et al., 2023). Pakistan is ranked among the countries most vulnerable to climate change, facing severe threats to its water security, economic stability (Ullah et al., 2023). However, agricultural role is increasingly threatened by temperature regimes due to change in precipitation patterns and rising frequency of extreme weather events (Abbas et al., 2023 & Cheema et al., 2023)

These changes have significant multiple risks to agricultural productivity which in turn dangerous for national food security and the livelihoods of millions in rural communities (Hussain et al., 2023). Irregular rainfalls, floods and abruptly changing weathers have taken thousands of precious lives and destroyed millions of agricultural land hectares in recent years in India, Bangladesh and Pakistan. Overall estimated financial loss reached $50 Billion. The previous studies discovered factors of climate change which include increase in average temperature, emission of CO_2 gas and severe monsoon rains (Aryal et al., 2020).

Despite the increasing recognition of this issue, there is marked need for comprehensive region-specific research that directly links the observed projected climate changes to agricultural outcomes. Existing literature highlights the complex interplay between environmental factors and crop production, yet there remains a gap in understanding how these dynamics manifest in the unique Agro-ecological context of Pakistan. This research paper aims to critically explore the multidimensional impacts of climate change on cereal crop yield in Pakistan.

Present study adopted the framework from the study of Jan et al., (2021) to see the impact of climate change on cereal crop yield in Pakistan. This study employed Autoregressive Distributive Lag (ARDL) model for the time period 1990-2024 to estimate the impact of climate change on cereal crop yield in Pakistan. The existing studies and literature on the association between climate change and basic cereal crop (wheat) is not very clear for the case of Pakistan; therefore, it needs a detailed empirical analysis.

This paper investigates the impact of climate change on cereal crop produce in Pakistan specifically considering the influence of temperature, CO_2 emission, precipitation, floods on the cereal crop (wheat) yield. This will help the farmers to get knowledge about adaptation for selecting weather resilient crop varieties. Similarly, policy and/or decision makers will be able to make feasible policies for food security and climate change. Additionally, this study will make climate change into practical comprehensions to rescue Pakistan agriculture and economy against present and future climate risks.

1. Review of Empirical Studies on Climate Change and Agriculture

Climate change is not only affecting the economy, but rather agriculture sector is also badly affected by climate change. Irregular rain triggers off landslides, heavy flooding, and crop losses. Heatwaves cause agriculture land productivity to decline as well as crop burning and droughts. All these issues and consequences are discussed in literature extensively. The previous literature provides a comprehensive outline of the relationship between agriculture yield and climate change.

Yusuf et al., (2025) assessed the impact of climate change on the yields of cereal crops. Climate change poses a severe challenge to Pakistan, where farming remains the backbone of the economy and rural livelihoods are highly climatic sensitive. Recent studies show that irregular rain fall, CO_2 emissions, and increasing temperatures have significantly reduced crop production, with wheat yields falling around by 6% and rice yields by 15%-18%, creating higher food prices, reducing farm income, and financial stress for rural households (Zulfiqar et al., 2020).

The devastating 2022 monsoons floods illustrated the severity of these impacts, as nearly 4 million hectares of crops were destroyed, over 1,700 lives were lost, 33 million peoples were affected and economic losses estimated at $15 Billion all of which intensifies food insecurity (Qamar et al., 2023). Long term climatic shifts reinforce these vulnerabilities, with Pakistan's annual temperature rising by and annual rainfall increasing by 25%, driving more frequent floods, storms, heatwaves and glacier lake outburst that endanger both ecosystems and communities (Amir et al., 2020).

Jan et al., (2021) claimed that climate change has emerged as a major threat to Pakistan, where rising temperatures, unpredictable rainfalls, and frequent extreme events have already started to damage the crops production. Studies across South Asia predict massive number of declines in stable crops, with wheat yields falling by up-to 50% in 2050 if adaptation is not prioritized (Aryal et al., 2020). Evidence from Pakistan confirms that these risks are damaging agricultural output and rural livelihoods (Mahmood et al., 2019; Hussain et al.,2020; Ahsan et al., 2020).

The northern region of Khyber Pakhtunkhwa, which is heavily dependent on rain-fed farming, is especially vulnerable to these climate shifts, as small changes in rainfall and temperature directly affect stable crops. Recent empirical research also showed that rainfall tends to improve yields, while higher maximum temperature significantly reduces it, especially for cereal crops like wheat and maize (Dubey & Sharma 2018; Chandio et al., 2020). In northern Khyber Pakhtunkhwa, precipitation had a strong positive effect on wheat and maize yields in the long run, whereas maximum temperatures were harmful and minimum temperatures showed limited influence except for short term benefits for maize (Jan et al., 2021). The study also showed that expended cultivated land improves production, suggesting that adaptive measures such as effective irrigation, land management and access to climate information are crucial to protect food security in Pakistan (Chandio et al., 2021; Warsame et al., 2021).

Climate change driven primarily by global warming represents a significant shift in long-term weather patterns for specific regions (Gaur & Squires 2018; Grover, 2004; Mahato ,2014). There are different definitions from leading bodies, the IPCC defines it broadly as any temporal climatic change whether from natural variability or human activity (Sethi, 2017). Whereas the UNFCCC focuses on changes attributable to human actions that change the atmosphere's composition (Grover, 2004). The temperature, wind and precipitation of the specific region are directly and indirectly affecting the economy and agriculture sector specifically. Food security, water resources and agriculture infrastructure as well as human livelihoods are threatened by sever climate change (Jawid et al., 2019). Similarly, human livelihoods are facing risk due to extreme weather situations such as decline in livestock productivity, crop yield productivity, droughts and floods (Mahato, 2014).

The agriculture sector of Bangladesh has been affected significantly by climate change. Crop yields, food security and prices are directly influenced by severe climate change (Tai et al., 2014; Rasul, 2021). Frequent extreme weather, floods, droughts and heat waves posture a substantial risk to agriculture sector specifically in the coastal areas of Bangladesh. These risks badly affected geographic and socio-economic status of society (Hossain and Joshi, 2025; Ahmed et al., 2021). These impacts increase food insecurity, a burden that falls disproportionately on women due to existing financial and political disadvantages.

Climate change is projected to severely reduce global yield of essential crops like wheat, rice and maize by the end of century (Roudier et al., 2011). If current trends continue, projections continue to suggest dramatic declines in production by 2100 especially a 5-50% decrease for wheat, 10-20% for rice and 20-45% for maize (Hassan et al.,2022). These threats combined with the recognition that existing farming procedures are often on shaky ground, as it inclines to discard significant sources and smash up the ecosystem (FAO, 2016). The focus is now on developing "next generation" crops that are more efficient with water and nutrients and can maintain stable yields under various environment stresses (Porfirio et al., 2018; Pareek et al., 2020). Consequently, there is a growing consensus that advancement in technology and scientific innovation is crucial to build resilient and adapt agricultural systems to the challenges of a changing climate (Bailey et al.,2019).

Climate change which is driven by rising emissions of greenhouse gases like CO_2 is a serious global change causing temperature increase, rise of sea-level and more extreme weather events such as droughts and floods (IPCC,2007; Stern, 2006). The agricultural sector is particularly vulnerable to this climatic instability, as crop productivity is directly affected by changes in temperature, rainfall patterns and water availability. These impacts are uniform while some regions may benefit others especially developing economies that rely heavily on agriculture face severe economic disruptions to supply demand and trade (Kaiser and Drennen 1993; Mendelsohn et al., 2001).

Climate change has severe consequences in Asia leading to heatwaves and distorted rainfall which alternatively compromises food security. The region is experiencing reduced yields of staple crops like rice, wheat and maize due to increasing

water stress and extreme weather with projections for South Asia indicating a potential 50% reduction in wheat productivity by 2050 (ADB, 2009; UNFCC, 2007; MoE,2009).
Pakistan is an example of such crises. As a country whose economy and large population are deeply dependent on agriculture, it is ranked among the world's most climate-exposed nations (MoE,2009). Moreover, projected temperature rises and erratic rainfall patterns pose a direct threat to its agricultural sector, a reality already evidenced by intense flooding and production losses underscoring the severe and immediate threat that climate change poses to the region's stability and food supply.
Cereal crop production is crucial for world food security and stable livelihoods for agricultural land. However, the weather is a major reason for crop yields to go up and down each year. In fact, studies show that climate can explain up to half of the yearly variation in food production, particularly due to extreme weather events (Ray et al., 2015).
According to Zscheischler (2020) and Ridder et al., 2022), biggest problem now is that these dangerous weather events are happening to occur simultaneously. Moreover, heat also makes droughts worse by making the air very dry which pulls more moisture out of the plants (Grossiord, 2019). Also, dry ground can make the air even hotter, creating a dangerous cycle. Most importantly, when a crop experience heat and drought at the same time, its reaction is different and much more severe than if it faces just one (Cohen et al., 2021). This makes it very hard to predict the impact on yields. This is especially because the world is getting warmer and future rainfall and soil moisture will change (Sheff et al., 2021).
Climate change has direct and harmful effect on food production causes serious economic damage in Pakistan, which has become a major government priority (Magsi and Sheikh, 2017). The country considered one of the most threatened by climate change globally (Javed et al., 2017), with studies consistently warning that it faces some of the world's highest potential losses in agricultural output (Rehman et al., 2016). The threat is both severe and specific; for example, a 1°C rise in temperature could wiped out hundreds or thousands of tons of vital wheat and rice production (Ali and Erenstein,2017). Therefore, some studies including one in Pakistan, suggest that technological improvements have so far, a bigger positive impact on yields as compared to the damage caused by climate change (Ahsan et al., 2020). Moreover, Janjua et al., (2014) established direct negative link between rising temperatures and wheat production within the country.
Keeping in view of above discussion, it is clear that climate change has a severe impact on the overall economy, with the agricultural sector being particularly affected. Crop losses have increased, the productivity of agricultural land has declined, and many individuals employed in this sector have faced job losses or reduced incomes. Consequently, these challenges not only threaten food security but also exacerbate poverty and economic instability, especially in rural areas.

2. Model Specification and Data

Climate change is now one of the major problems in the world with a particular impact in the areas of food production (IPCC, 2022). Punjab, the agricultural hub of Pakistan, is also becoming more susceptible to the impacts of the increasing temperature, changing rainfall patterns and severe climate incidents, which are having a substantial effect on the farming efficiency, water security and economic stability of the province (Ali et al., 2023; Ullah et al., 2023).

2.1. Model Specification

In order to explore the impact of climate change on cereal produce yield in Pakistan, it is necessary to specify and estimate a model that links these variables together. ARDL model can be formulated by using following equations:

$$WheatYield_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i WheatYield_{t-i} + \sum_{j=0}^{q_1} \beta_j CO2_{t-j} + \sum_{k=0}^{q_2} \gamma_k Temp_{t-k} + \sum_{l=0}^{q_3} \delta_l ARF_{t-l} + \sum_{m=0}^{q_4} \phi_m Floods_{t-m} + \mu_t$$

whereas *t* in the subscript denotes the time period from 1990 to 2024. CO_2 represents the annual atmospheric concentration (ppm). *Temp* refers to the monthly mean, highest, and lowest temperatures during the growing time of year (November–April), obtained from the Pakistan Meteorological Department (PMD). *ARF* denotes total precipitation during the growing season, also sourced from PMD. *Floods* is a binary indicator, taking the value of 1 if a district was affected by flooding during the growing season, along with the percentage of flood-affected areas (PMD data).
Additionally, annual flood occurrence is captured through a dummy variable, where 1 represents major flood years in Pakistan (2010, 2011, 2014, and 2022), and 0 represents all other years.

2.2. Data and its sources

The present report uses the time series data from 1990-2024. The study focuses on a major cereal crop in Pakistan, i.e., Wheat. The data on cereal crop yield was obtained from Food and Agricultural Organization (FAO). Temperature and precipitation, floods and CO_2 related data were taken from the Pakistan Meteorological Department, World Bank and National Disaster Management Authority of Pakistan (NDMA).

2.3. Estimation Techniques

The impact of climate change on cereal crop yields in Pakistan is analyzed by selecting an appropriate econometric technique after determining the order of integration of the variables using the Augmented Dickey-Fuller (ADF) unit root test. Since the variables are integrated of mixed orders, I(0) and I(1), the Autoregressive Distributed Lag (ARDL) approach is applied due to its suitability for small sample sizes and its flexibility in handling mixed integration levels. The ARDL bounds testing procedure is used to assess the existence of a long-run cointegrating relationship among the variables, while model stability is evaluated through the CUSUM and CUSUMSQ tests. In addition, diagnostic tests for heteroscedasticity, serial correlation, and normality are performed to ensure the robustness and reliability of the estimated results.

3. Results and Discussion

Climate change is an increasing concern in the international community, and the trend is same in regions where the density of the population is higher and there is reliance on agriculture (IPCC,2022). Punjab, Pakistan is an important part of Pakistan and is known to produce the major crop in the form of wheat, rice, and corn (Ali et al.,2023). Pakistan is one of the countries highly affected by climate change and across which the impacts of climate change have been vulnerably posed on the water resources and economic systems in the country (Ullah et al.,2023). Nevertheless, the impact of agriculture is now facing threats in the form of climate change due to the associated warming in temperature patterns due to changes in precipitation and extreme weather occurrence (Abbas et al.,2023, Cheema et al.,2023).

3.1. Empirical Results

Wheat is used as the representative cereal crop in this study for the regression analysis. The estimate is made for the purpose of evaluating the influence of climate change on cereal crop yield, particularly on wheat production. The results of the estimation are as follows:

3.2. Unit Root Test

For the case of time series analysis, the stationarity of the variables has to be checked to determine the order of integration (Ali et al., 2015). The results are presented in **Table 4.2.1**. The unit root test results indicate that CO_2, temperature, rainfall, wheat production are stationary at first difference

(Integrated of order one). Floods over the year are stationary at a level showing level of integration at zero. It means that ARDL bound testing procedure is applicable to check the long run relationship between the variables (Ali et al., 2015).

Table 4.2.1: Unit-Root Test

Variables	Levels		1st Difference		Results	Order of Integration
	t- values	P-Value	t- values	P-Value		
Wheat	-2.15	0.22	-9.56	0.00	Stationary at 1st difference	I(1)
CO_2	-1.78	0.38	-4.70	0.00	Stationary at 1st difference	I (1)
Temp	0.49	0.62	-5.24	0.00	Stationary at level	I (1)
Rainfall	0.05	0.69	-6.17	0.00	Stationary at level	I (1)
Floods	-5.11	0.00	7.28	0.63	Stationary at level	I (0)
Critical Value at 1% is -3.63, 5% is -2.95, and at 10 % is -2.61.						

4.2.2. The Bound Testing Approach

The Bounds Test is employed to check if there is a long-term relationship between variables. From the Bounds Test, it is clear that there is a long run relationship between the variables. Based on this value of F, it is observed from **Table 4.2.2** that it is greater than all the upper critical F values at all the significance levels. So the null hypothesis, that there is no long run relationship, is rejected, and the alternative hypothesis, that there is a long run relationship (H1) is accepted.

Table 4.2.2: Bound test result

Equation	F-statistics	Significance level %	Critical bound F-statistics	
			I (0)	I (1)
EQ.1	5.63	5%	3.05	4.22

Once the conditions for the Bounds Testing approach are established, the estimation of the long-run and short-run results such as the Error Correction Model (ECM) can be carried out. The long-run relationships and the short-run relationships are presented and discussed in the following paragraphs.

4.2.3 Diagnostic Tests and Stability Test

For the countries' case of Pakistan, series of diagnostic test and CUSUM test have been applied to test the stability of ARDL model. The following results of these tests are outlined early for presentation purposes, but after long-run results have been estimated. The results are consistent with the validity of the long-term estimates. The results of the diagnostic tests are presented in **Table 4.2.3,** and the results of the stability test are presented in the graphs below:

Table: 4.2.3 Diagnostic Tests

Post estimation Test	Prob. Value
Heteroskedasticity Test	0.41
Breuch-Godfrey Serial Correlation LM Test	0.66
Normality Test	0.77
*P > 0.1, then reject null hypothesis.	

The results show that there is no autocorrelation in the residuals. Furthermore, the results indicate that there is no evidence of heteroscedasticity. The normality test shows that the error term is normally distributed. Finally, the stability test reveals that both CUSUM and CUSUMSQ do not deviate from the specified critical range signifying that the ARDL model's coefficients are not rejected as unstable at 5 percent level for Pakistan. This is to verify the stability of the model. The overall results indicate that the data in this study is normally distributed and the overall model is stable.

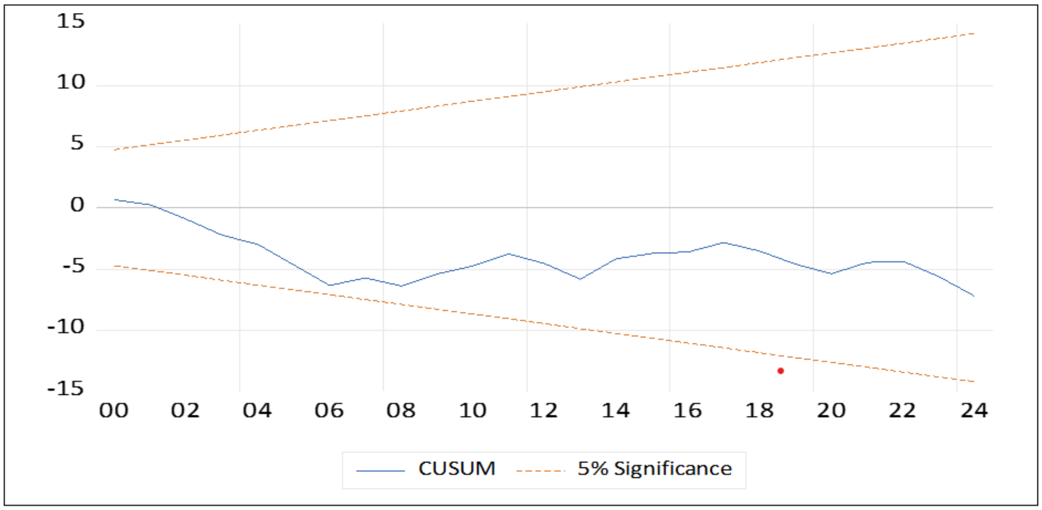

Figure-1 Stability Test through CUSUM

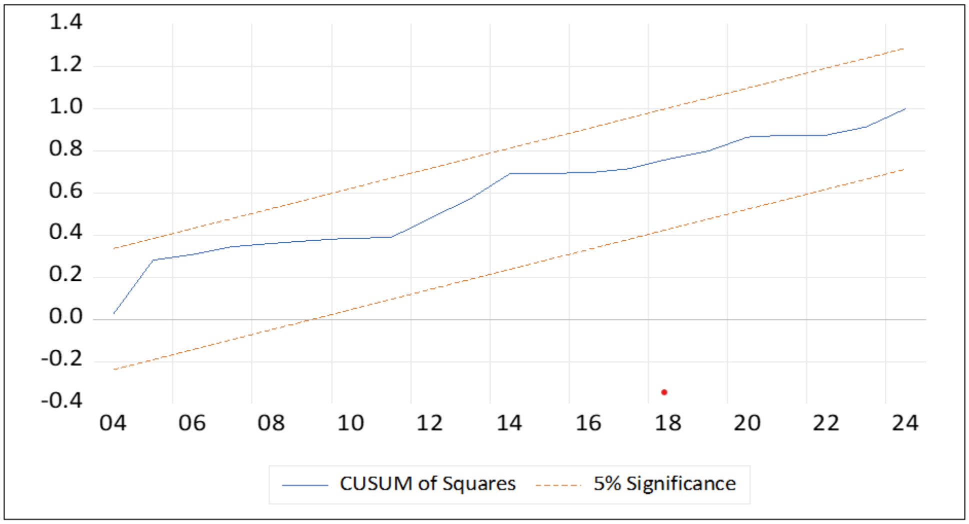

Figure-2 Stability Test through CUSUMSQ

3.3. Short Run Results

It is eminent to consider the short-run results prior to discussing the long-run results. The short-run wheat production estimates are given in **Table-4.3**:

Table 4.3 Short Run Results

Eq.1Variables	Coefficient t-value
D (CO_2)	-0.31 (-4.70) ***
D(TEMP)	1.79 (4.80) ***
D(ARF)	-1.86 e-04 (-3.62) ***
D(FLOOD_YEAR)	-0.04 (-3.17) **
ECT	-3.44 (-7.61) ***
***=1 %, **=5%, *=10%	

Based on these findings, one conclusion is that the wheat production will decrease by 0.31 unit with every tonne of CO_2 emission. The 1°C increase in temperature will, however, lead to a short run increase in wheat output of 1.79 units, depending on the stage of the wheat crop's growth. Increase in harvest yield drops nearly by 0.00186 units for every 100 mm increase in rainfall during harvest. An increase in rainfall during harvest period by 100 mm would lead to almost 0.00186 decrease in the yield. Also, during a major flood year, there is a one-time reduction in wheat production of 0.04 units.

The ARDL model can be converted into the Error Correction Model (ECM) by a simple linear transformation (Banerjee et al., 1993). The short run relationship is a relationship which describes how the model moves towards the equilibrium path and is called the ECM for the short run relationship. It also combines the short run with the long run, while preserving long run information. The ECM results show that the error correction term is negative and statistically significant, and has a coefficient of −3.44, which shows that the speed of adjustment is very fast. It means that the short-run climatic fluctuations' impact on wheat production is being lessened by around 344% in a single year, which shows how responsive and volatile the wheat production is in Pakistan to climatic fluctuations.

4.4 The Long Run Results

Long run results for all the variables of interest are presented in **Table-4.4**. The results are employed to explain the long time period correlation of the wheat crop yield and temperature, CO_2 emission, precipitation, floods in the model. The results also show the change in wheat production due to climate and non-climatic factors over time. This study aimed at an analysis of impact of climate change on wheat yield in Pakistan. The main climate variables analyzed were CO_2 emissions, temperature, rain and extreme flood events.

The "flood years" were found to be most significant variable as it had significant negative effect on wheat yield of Pakistan. The table below displays the long-run results, indicating that wheat yield decreases by about 6 percent due to a major flood year. The finding is in line with recent history and literature, such as Pakistan's devastating flash floods in 2010, 2011, 2014 and 2022. These floods caused considerable food insecurity problems, resulting in agricultural losses of billions of dollars (World Bank, 2022; NDMA reports). Flood causes immediate and ongoing loss of production, kills standing crops, waterlogs fields and causes soil degradation.

There is a double and complex relationship between CO_2 and wheat production. The agronomic literature suggests that a 1-ton increase in CO_2 emission is correlated to an increase in yield of 0.39 unit in the long run, due to the temporary CO_2 fertilization effect identified in the literature (Ainsworth & Long, 2005). This is due to the fact that wheat is a C3 plant and would be able to have increased photosynthesis at high CO_2 levels. But, the short-run impact is negative (-0.31), indicating that heat stress and higher levels of pollutants can have a detrimental effect on crops. This dual impact is confusing because the apparent long-term benefit of CO_2 is false, because CO_2 emissions are the cause of climate change, leading to more weather extremes such as floods than before.

The long run effects of temperature on crop yields are positive and significant, indicating a favorable outcome. Specifically, one percent rise in temperature boosts crop yields by 0.82 percent. It means that rise in average temperature (not extreme heatwaves) has a beneficial role in crop yields productivity in Pakistan. This is due to the reduction in cold stress or growing seasons are extended. Rainfall did not show a statistically significant impact on wheat yield in the long run. This is due to wheat cultivation in Punjab, Pakistan's breadbasket which is irrigated and relies on canal systems and ground water rather than direct rainfall. The short run negative coefficient may reflect the damaging impact of untimely or excessive rainfall that causes waterlogging.

Table: 4.4 Long Run Results

Regressors	Coefficient (t-value)
C	4.82 (12.18) ***
CO_2	0.39 (40.12) ***
TEMP	0.81 (3.61) ***
ARF	9.35e-05 (1.52)
FLOOD_YEAR	-0.59 (-6.39) ***
***= 1%, **=5%, *=10%	

4. Conclusion and Policy Recommendations

4.1. Conclusions

The present report directs to find out the effects of climate change on wheat production in Pakistan between 1990 and 2024. The study used ARDL to explore the long run and short run association among the climate change instruments and cereal crop yield in Pakistan. Climate change imposed extreme weather is adverse for the agricultural productivity, particularly on the staple food crops such as wheat. The failure in wheat crop production directly impacts the livelihood of the people and food security of an agriculture country like Pakistan.

The beneficial effect of CO_2 emission on the yield of crops is similar to CO_2 fertilization effect. This is a short-term effect and offset by climate change destructive impacts. In particular, heavy rainfall and flooding seriously affect the productivity of staple food crops in Pakistan. The results highlight the need to improve strategies to make agriculture more climate resilient, water management and flood protection measures to mitigate wheat losses and food insecurity.

4.2. Policy Recommendations

From the results of this study, following policy suggestions are recommended to lower vulnerability of wheat production in Pakistan during climate change conditions and to enhance food security in the long-term.

1. Improving climate smart Agri-technology practices

Promotion of climate-smart agriculture practices, like heat and flood tolerant wheat varieties, as well as adjusted sowing dates and conservation agriculture practices is needed. These can be used by farmers to adjust to increased temperature variability and extremes.

2. Enhance flood management and early warning system.

Investment in modern flood forecasting, early warning and drainage infrastructure is imperative as floods have a significant negative impact on wheat yield. Institutional development of the NDMA and Local disaster management authorities can help minimize crop losses during extreme rainfall events.

3. Improving the management of water resources

Optimize irrigation water use (drip and sprinkler irrigation) to minimize water loss and enhance resilience to rainfall variability. Improved water storage and canal management are also essential to ensure stable production for agriculture.

4. Increasing agricultural research and development.

More public and private sector investment is needed to bring to fruition improved agricultural technology and varieties that are more climate resilient. Innovation can be sped up by cooperation with international agricultural research centers.

6. Investing in innovative technologies for farming.

Farmers need to be supported against climate-induced losses through targeted subsidies, crop insurance and financial support should be expanded. There is a need to further enhance and expand locally training programs on adaptive agriculture practices.

7. Including Climate Change in Agricultural Policy Planning

National agricultural and food security policies should incorporate climate change considerations. Long-term strategies need to consider a growing climate risk instead of production opportunities.

8. Improving energy efficiency

CO_2 has short-term fertilization effects but is detrimental for long term climate change. Thus, promoting low emission farming technologies, renewable energy utilization and better land utilization in Pakistan is welcome in the context of mitigation efforts.

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