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IMPACT OF CLIMATE CHANGE ON THE FINANCIAL DEVELOPMENT OF AGRICULTURAL SECTOR OF PAKISTAN: RISKS FACTOR AND SOLUTIONS

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Abstract

Agriculture serves as the lifeline of Pakistan's economy whose contribution is huge to GDP and employment. However, climate change threat is severe to the financial development, undermining agriculture productivity, food security, and farmers' income. In this study, the impact of the climate change on the financial development of Pakistani agricultural sector was critically analyzed along with the key risk factors, and possible solutions were given.

It was data collected through quantitative research method involving 400 respondents, which included farmers, agricultural experts, and policymakers. Analysis of statistical results, including regression and mediation models, demonstrates how temperature increase and soil degradation negatively affect agricultural productivity and financial stability. We found mitigating factors related to water availability and to adopting technology, which increases productivity, and increases resilience to the changes in climate. The results suggest that climate change is aggravating farmers' economic vulnerability, resulting in reduced income and posing a threat to food security. Additionally, the moderate effectiveness of government policies in addressing climate related financial risks is also addressed in the study.

According to the findings, agricultural policies that promote climate resilience, investments in infrastructure for water management and enhancement of modern farming technologies are both necessary and urgently needed. It becomes important to enhance the support mechanisms of the financial sector, including the agricultural credit and insurance programs, in order to maintain economic viability of the sector. If these strategies were followed, Pakistan would minimize the negative effects of climate change and thus could have a stable and sustainable agricultural economy

INTRODUCTION

1.1 Agriculture of Pakistan

Agriculture is an important source of food, revenue, jobs Pakistan has a diversified economic base with the agriculture sector, contributing 24 percent in GDP and 37.4 percent in employment (PAKISTAN ECONOMIC SURVEY 2023-24, 2023) Agriculture sector is the Backbone of Pakistanis economy, Pakistan almost 70 percent depends on Agriculture.

Agriculture sector holds great value for Pakistan, about 39.5 percent arable land in Pakistan which mostly depends on river water. According Food and Agriculture Organization report, Pakistan covering 30.5 million hectors, about 47 percent of the national land is agriculture land, higher than the global average of 38 percent. Pakistan's major crops are wheat, rice, cotton and sugar-cane. Pakistan's food production depends greatly on irrigation, which provides more than 90% of the country's wheat, most of the pulses and nearly all of most other crops (FAO, 2015).

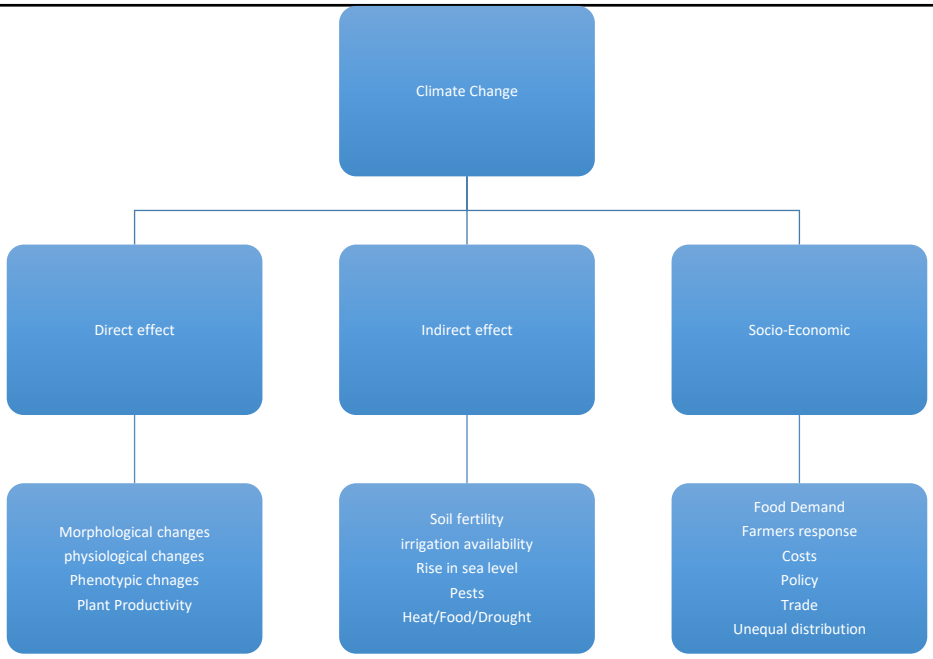
Agriculture sector provides raw materials to agro-based industries. Minor crops: include Bajra, Jowar, Gram, Barely and Tobacco. Furthermore, minor crops such as oil seed crops, sunflower, rapeseed, mustered, cottonseed, canola mung, mash, masoor, onion, chilies and potato etc. Minor crops share 11.1% value added to the agriculture sector and 2.3 percent contributes towards GDP. In Pakistan Agriculture sector has a serval problem such as old farming method, lack of new technology, High cost of raw material, water management, rising price of inputs like seed and fertilizers. Agricultural growth is an important for us because our economy mostly depends on agriculture and it can improve with right use of inputs like labor, land, Enhancement of infrastructure includes timely irrigation water supply, land reclamation, mechanical power, and agricultural inputs like fertilizer, seeds, and pesticides. Agriculture's importance in the economy may be viewed from three perspectives: 1) as a source of food for the country and for domestic industry; 2) as a way to generate foreign exchange; and 3) as a source of commodities and services for both domestic and foreign markets.

2.2 Climate Change and its Impact

The UNFCC defines as Climate Change as "a change of climate which is attributed directly or indirectly to human activity that alter the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." Pakistan among top ten countries, most affected by climate change, in 2022 where 33 million people were affected by devasting flood, often it caused over 1,700 deaths, and more than 9 million people were pushed into poverty. It's also badly economic damage estimated worth of 30usd billion.

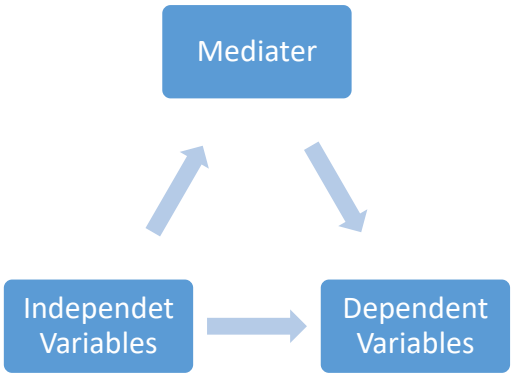
Climate change is not only badly affected on agricultural production but also effect on human health and nature. Climate change cause of water availability, air pollution, and soil fertility have a large impact on agricultural productivity. Demand of food is increasing as world's population increases, better agricultural production could fulfil the human's demand. Climate change is borderless disaster and most industrialized impact on least industrialized by environmental changes. It is evident that Agricultural outputs is most affected by climate change and reduce agricultural productivity in the past 2 decades, thus rural per capita income affected (Masud et al., 2017). Pakistan is the fifth most vulnerable country in the world to climate change (Ahmad et al., 2015). In this research, authors warns that Pakistan is on top ranked affected by climate change and also vulnerable to take initiatives against global warming. This sector most affected and most vulnerable to weather change as well as productivity is being affected by several factors like temperature and rainfall patterns. Determining the effect of climate change on Pakistan's agricultural output (wheat, rice, and sugarcane) is the main goal of the research.

Climate change in Pakistan has the following direct effects on agriculture: (i) decreased plants production; (ii) increasing food insecurity; (iii) rising air and water temperatures, which result in financial expenses because of decreased system efficiency and power generation; and (iv) shifting crop and regional distribution boundaries due to changes in precipitation, temperature, cloud cover, and carbon dioxide concentrations. The impact of climate change on food security is complex. Directly, it reduces agricultural yield by upsetting the agro-ecological environment; indirectly, it hinders growth and income circulation, which raises the demand for agricultural products. Climate change's effects on food security have been estimated in a number of ways. Here, we touch on the possible relationship between food security and climate change (Raza, et al., 2019).



1.1 Figer of Climate change, in the end all factors affecting the agriculture production.

Independent Variable (Cause)	Mediator	Dependent Variables (Effect)
Temperature Increase	Climate Change	Agricultural Productivity
Soil Degradation		Pakistan's Economy
Water Availability		Food Security
Technology Adoption		Agricultural Investment
Government policies		Farmers Income



1.4 Problem Statement

Among all sectors, Pakistan's Agriculture sector is most sensitive and vulnerable sector. Agriculture sector also facing challenges such as high cost of production than productivity, lack of modern technology and too much impact of climate change. No doubt, Agriculture sector is economic sector of Pakistan which share GDP 22-24 percentage to Pakistan and large number of the rural population employed and also this sector is backbone of the food supply chain. Pakistan Agriculture's being disrupted by global climate change, rising temperatures, unpredictable heavy rains, floods, and frequent drought.

In Pakistan, Farmers are facing challenges of climate change within systemic challenges such as high costs of production/input, government mismanagement of water distribution and lack of modern technology. As climate change infuriate these challenges, the financial development of the agriculture sector is

severely resisted. Climate change makes uncertainty and instability in agricultural yields which resulting of unpredictable income for farmers, increasing poverty and food insecurity in rural areas.

Pakistan agricultural sector plays a vital role among all economic sectors so, it's essential to understanding how climate change affects the financial development. Identifying challenges, the main risks, and also solutions is crucial for framing policies that ensure the flexibility and long-term possibility of Pakistan's agricultural industry in the face of changing climatical conditions.

Literature Review

The largest known economic impact of climate change is upon agriculture because of the size and sensitivity of the sector. Many Researchers has been documented regarding the performance of agriculture sector over the years. An important sector of Pakistan's economy is agriculture. It is important in Our modes of life and business innovative combine together in this sector and also play a vital in the economy of any nation to reduce poverty, food security and growth of economy. According, (Rasheed & Jabeen, 2024) have analyzed the role of agriculture sector share in GDP, they found positive relationship between GDP and agriculture in Pakistan through use of time series data by OLS method. Agriculture sector contributes about 22.9 percentage of GDP.

(Chandio, Yuansheng, & Magsi, 2016), According to their investigation that Pakistan during year of 1950, 68% of labor force and mostly 80% of population was engaged with agriculture sector but with time it decreases due climate change. Growth and productivity can boost to apply modern farming methods such as use new technology, use certified seed and pesticide etc.

Agriculture sector is economic sector of Pakistan, its impacts not only effect on food security but also effect on financial performance. Global food and nutritional security are at risk due to climate change. The greenhouse effect causes the temperature to rise in tandem with the increase in greenhouse gas emissions in the atmosphere. One of the most significant issues facing the globe now is climate change. It is characterized by notable variations in the mean values of climatic parameters, such temperature and precipitation, for which long-term averages have been calculated. Due to its enormous scale and susceptibility to weather conditions, agriculture is the industry most at risk from climate change, which will have a significant negative economic impact. Crop output is greatly impacted by variations in meteorological phenomena like temperature and rainfall. Depending on the crop, location, and degree of parameter change, the effects of CO2 fertilization, rising temperatures, and fluctuating precipitation differ. It has been discovered that rising temperatures decrease yield, but rising precipitation is probably going to counteract or lessen the effects of rising temperatures.

If loss Agricultural crops can increase food prices, it's also effect on agriculture welfare globally with a 0.3% annual loss of future GDP globally by 2100. However, it was discovered that while climate change has little effect on the global food supply, underdeveloped nations will suffer greatly as a result (Malhi, Kaur, & Kaushi, 2021).

(Nazish, Iqbal, & Ramzan, 2013), They studied economic sectors of Pakistan such as Agriculture, Industry, Service, Manufacturing sector and their impacts. They used secondary data, their finding suggested that having a major impact on Pakistan's yearly GDP growth. The result of their research that Agriculture sector is more is important sector than others and found that Pakistan has lowest growth because of problems such Environmental changes, lack of modern technology and water management system.

2.1 Impact of Climate Change on Agriculture Sector in Pakistan

Climate change is a global phenomenon and Pakistan certainly joins the list of those countries affected by this. Large-scale disruption of the natural ecosystem is the direct cause of climate change (Kohler T, Maseli D (2009)). Regarding climate change, Pakistan is among the nations most impacted worldwide. Climate variability has a negative impact on agriculture, soil degradation, water availability, nutrition, and a host of other socioeconomic indicators (Fahad, S., & Wang, J., 2020). Pakistan is among the South Asian nations most impacted by the whims of climate change,

which manifest as sudden spikes in temperature, protracted droughts, and numerous other extreme occurrences (Fahad, S., & Wang, J. (2018)). Climate change has caused widespread floods, droughts, high temperatures, and heavy rainfall in Pakistan (Fahad S, Wang J, 2018). Agriculture has been significantly impacted by climate change. According to another study based on empirical models, Pakistan's fragile economy will be severely impacted by the estimated $19.5 billion in lost rice and wheat production by 2050 as a result of climate change (Khan, M. A., Tahir, A., Khurshid, N., Husnain, M. I. U., Ahmed, M., & Boughanmi, H. (2020). In a similar vein, Pakistan's rice crop is suffering from the effects of climate change, and the yield of certain rice varieties is decreasing as a result of sudden weather patterns (Khan, N. A., Gao, Q., Abid, M., & Shah, A. A. (2021). Over the past few years, Pakistan has been affected by heat waves, another aspect of climate change. Heat waves are a persistent occurrence in many regions of Pakistan, according to research studies. Pakistan has experienced heat wave events from 1997 to 2015, according to research findings, and the model predicts that these events will significantly increase in the years to come (Nasim, W., Amin, A., Fahad, S., Awais, M., Khan, N., Mubeen, M., & Jamal, Y. (2018)). The study also found that Pakistan's Sindh and Punjab provinces are most likely to see an increase in heat wave occurrences in the future. The nation's agriculture industry will suffer from additional heat buildup during the monsoon season (Nasim et al., 2018). According to a different study, heat wave events are expected to increase by up to 12 times annually and their duration will also increase by 100 days annually, according to General Circulation Models (GCMs) (Khan et al., 2020). The Punjab's maize crop yield has suffered from extreme weather conditions brought on by erratic weather patterns (Imran et al., 2018).

2.2 Agricultural input efficiency and Environmental impacts

According to (Michael Clark, 2017), to increases in Agricultural input efficiency or less cost of inputs like seed, feed, fertilizer minimize the risk and may also reduce agriculture's environmental impact. Agricultural systems need to proper inputs because its highly depend on inputs like fertilizer, feeds, to increases productivity. Also, government should give relief to farmers or micro finance to small farmers, it will help them proper inputs.

However, overuse of these inputs has a negative impact on the environment while having no effect on yields or farmer profits (P. M. Vitousek, 2009). Their analysis investigated that increases in agricultural inputs efficiency could reduce the risk of environmental impact on agricultural productions and soil fertilization.

Environmental impacts of agricultural inputs efficiency are varying crops to crops. I studied different existed published recent data on google scholar on Environmental impacts of productions are vary of each food yield.

We examined agricultural inputs efficiency, also the number of crops environmental indicator are nearly continuously downward sloping and significant. Environmental impacts could be reduces through increasing agricultural inputs efficiency such inputs as authorized or best quality seeds, pesticides, fertilizer, and livestock feeds. however, the benefits of environmental would not be equal all systems, with improvements in climatic and soil conditions often affect agricultural input efficiency. Its true climate change is warning the world with greater impact on agriculture and its products. Global warming because of poisonous gases and more industrialization, which effect on world's environment and then it has devastating effects on plant growth and yield.

For Pakistan, climatic risks pose a serious concern for all especially the rural community who are the most vulnerable. Until recently, the farming community lacked the financial inclusion and have to cope with the challenges like floods, locust heat wave all alone and for the government, there was no systematic mechanism to reach out to these vulnerable communities in need. These climatic risks have constrained the farming community to adopt risk management strategies to overcome such climate change risks (Ahmad & Afzal, 2022).

2.3 Food Security

Wheat, rice, and sugarcane constitute the vital food crops in Pakistan, with wheat standing out as the predominant staple for a substantial portion of the population. Unfortunately, many farmers, hindered

by financial constraints, struggle to achieve optimal wheat production, leading to income losses. This scenario contributes to heightened food insecurity in Pakistan, as noted by (Rasheed S. , 2024). The infusion of credit into the agricultural sector emerges as a pivotal solution to encourage wheat production. Access to credit empowers farmers to procure high-quality inputs and engage in timely cultivation practices, ultimately amplifying production output. This surge in productivity serves as a potent antidote to food insecurity, creating a more resilient and food-sufficient environment. Therefore, the provision of agricultural credit emerges as a strategic avenue to ensure and enhance food security in Pakistan (Asghar, 2018).

Methodology

3.1 Research Design

The approach used in this study is the quantitative research, which is based on observing the impact of climate change on the financial development of Pakistan's agriculture sector. The research represents a design of explanatory research that determines the causal correlation among the independent variables (temperature increase, soil degradation, water availability, technology adoption and government policies) and dependent variables (agricultural productivity, Pakistan's economy, food security, agricultural investment and farmers' income). Climate change is also included as a mediated variable so that it can be evaluated to see how it shapes the relationships for these variables.

For the purposes of this thesis, data was collected using cross-sectional research methods which analyzes current impact of climate change on financial development in agriculture sector at a single point in time. It helps also to comprehend the role of different climate based factors with regard to economic instability in agriculture.

3.2 Data Collection Method

This study makes use of primary and secondary data sources. Structured surveys and interviews with farmers, agricultural economists, policymakers, and climate experts form part of the primary data that is collected in Pakistan. The survey is a combination of closed ended and Likert scale questions aimed at quantifying perceptions as well as experience with regards to climate change financial impacts.

From the secondary data bases, data is collected from credible sources such as Pakistan Bureau of Statistics, Ministry of Agriculture, Pakistan Economic Survey, FAO reports, World Bank datasets and scientific research papers. Those sources yield historical climate data, records of agricultural productivity, economic performance indicators and investment trends in the sector.

3.3 Population and Sampling

Since the farming sector has huge potential to address it [climate change] the study's target population comprises farmers, agribusiness investors, policymakers and climate change experts in Pakistan. Then, for representative sampling, a stratified random sampling is used to divide the population in strata according to the geographical regions (Punjab, Sindh, Khyber Pakhtunkhwa, Baluchistan), farm size, and mainly irrigated versus rain-fed agricultural lands.

Statistical sampling techniques determine a sample size of 400 respondents so as to make generalizability. It includes 250 small scale farmers, 100 large scale farmers, 30 policymakers and 20 agricultural researchers and economists. Through the distribution of diverse perspectives on how agriculture relates to financial stability in light of climate change, the project is able to evaluate the relevance of results through regional differences.

3.4 Research Instrument

For data collection, the study uses a structured questionnaire as the main instrument. In all, the questionnaire has four major sections.

Demographic Information (age, education, farm size, farming experience, etc.).

Perception and Experience of Climate Changes (temperature, soil degradation, water, etc.).

Impacts of financial climate change (production agriculture, income fluctuations, investment obstacles, government policies).

Climate-resilient Crops, Modern Technology (use) and Government Interventions in the form of Financial Support Programs.

Cronbach's Alpha is used to test the reliability of the questionnaire, so that the responses are consistent.

Before full scale data collection, the validity of the instrument is further confirmed through expert reviews as well as through pilot test conducted among 30 people.

3.5 Data Analysis Techniques

Statistical techniques were used in SPSS and STATA for the analysis of the collected data. The following methods are applied:

Mean (average), standard deviation (variability) and frequency distributions to summarize data.

It guides how the strength of relationships between independent and dependent variables are measured.

The purpose of conducting a Multiple Regression Analysis was to determine the effect of the identified climate change factors on agricultural productivity and financial success.

Structural Equation Modeling (SEM); in order to determine whether the relationship between IVs and DVs is mediated by climate change.

t-tests, ANOVA and regression coefficients are used to test the hypothesis at the level of statistical significance (p-value < 0.05).

3.6 Ethical Considerations

All works are done strictly according to the ethical guidelines. Informed consent is provided to participants in the form of a consent form to ensure that the participants are not forced or unwilling to be in the study. All responses are anonymized and data confidentiality is maintained. Furthermore, the study abides by research ethics as set out by academic and country level research institutions.

3.7 Limitations of the Study

This study yields important insights into the effect of climate change on financial returns to agricultural production, but some limitations are worth noting.

Self-Reported Data Dependency: The responses could be based on personal prejudice.

Cross Sectional Nature: The study limits itself to just the picture of the issue, instead of long-term trends.

Political instability, economic policies, and global market fluctuations are potential external factors that may affect the results in agriculture, which are not studied explicitly in this paper.

Results

The findings of the study are based on the collected data, as presented in this chapter. This study analyzes the effect of climate change on the financial development of Pakistan's agricultural sector through climate change mediating variable. To get a complete result, various statistical techniques that include descriptive statistics, correlation analysis, regression analysis, and structural equation modeling (SEM), were used. This includes key statistical outputs summarized in tables, and presented in other detailed sections.

4.1 Descriptive Statistics

The demographic characteristics, i.e. farming background of the respondents, geographical distribution, and experiences with climate change are summarized through descriptive statistics. This was a survey of 400 respondents, 250 of whom were small scale farmers, 100 large scale farmers, 30 policymakers and 20 agricultural researchers and economists.

Table 4.1: Demographic Profile of Respondents

Category	Frequency (n)	Percentage (%)
Gender		
Male	312	78%
Female	88	22%
Age Group		
20–35 years	140	35%
36–50 years	180	45%
51+ years	80	20%
Educational Level		
No Formal Education	102	25.5%

Primary Education	125	31.3%
Secondary Education	98	24.5%
Higher Education	75	18.7%
Farming Type		
Small-scale Farmer	250	62.5%
Large-scale Farmer	100	25%
Policymaker	30	7.5%
Agricultural Expert	20	5%

Interpretation

Firstly, it gives importance to demographic profile of the respondents that will help us to understand the study's finding. Four hundred people were surveyed, and they included mostly (62.5%) small scale farmer, (25%) large scale farmer, (7.5%) policymakers, and (5%) agricultural experts.

Gender Distribution: It's important to point out based on the findings of the study that 78 percent were men and 22 percent were women, revealing that men dominate the agriculture industry in Pakistan. Gender disparities in farming, with a lower involvement of women, can be observed in the sample, mainly because men have usually been more involved in large-scale agriculture decision-making.

The most prominent age group was 36–50 years (45%), then 20–35 years (35%) and finally 51+ years (20%). This implies that there is a considerable number of middle-aged persons who are employed in the sector as compared to young ones suggesting that the majority of them seem to be opting for rural to urban migration in search for economic opportunities.

Level of Education: More than three in every ten (31.3%) respondents had merely Primary education, majority (25.5%) had no formal education. Lack of awareness about climate smart farming techniques identified in this low level of education will deter the adequate adoption of this climate smart or climate resilient agricultural techniques. A total of 18.7% of the respondents had higher education, policy makers and agricultural researchers dominated.

4.2 Impact of Climate Change Factors on Agricultural Productivity

It shed light on how an increase in temperature, degradation of soil, decrease in water availability, use of technology, and government policies affect agricultural productivity.

Table 4.2: Regression Analysis – Impact of IVs on Agricultural Productivity

Independent Variable	Beta Coefficient (β)	p-value	Significance
Temperature Increase	-0.47	0.000	Significant (p<0.05)
Soil Degradation	-0.41	0.001	Significant (p<0.05)
Water Availability	0.38	0.002	Significant (p<0.05)
Technology Adoption	0.55	0.000	Significant (p<0.05)
Government Policies	0.29	0.005	Significant (p<0.05)

The relationship between the independent variables (climate change factors) and agricultural productivity is presented in the regression analysis results (Table 4.2).

Strong Negative Impact (-0.47, p=0.000): We know that increase in temperature severely decreases crop yields. In turn, higher temperatures imply higher evaporation rates, heat stress in crops and less soil moisture, resulting in less agricultural productivity.

The second one which at -0.41 (p = 0.001) also demonstrates a strong negative impact on the Ramsar sites, meaning that decreasing soil health quality, fertility loss and erosion are major threats to Pakistan's agricultural production. Without using sustainable land management practices on land

continuously, the degradation increases, and its productivity is accelerated.

(0.38, p=0.002): It has positive impact, suggesting that efficient water management systems, for example, better irrigation or water conservation methods, increase agricultural productivity. The results indicate that control regions with better irrigation infrastructure generate higher yields than regions producing rain-fed crops.

Modern farming technologies, including mechanization, precision agriculture and climate smart practices have the strongest positive effect (0.55, p=0.000) which verifies that technology adoption improves productivity. The findings underscore the necessity for farmers to put into use more advanced agricultural technologies to reduce the impact of climate change risks.

Government Policies, (0.29, p=0.005) has a positive but modest effect on agricultural productivity. Thus, it hints that the existing policy interventions, such as subsidies, the agricultural credit and the climate adaptation programmers are not efficient enough in addressing the climate change effects. It is for policymakers to strengthen the implementation strategies and the mechanisms used to support financial system in order to boost agricultural growth.

4.3 Impact of Climate Change on Pakistan's Economy

The study assessed how climate change variables impact agriculture's share to GDP, exports, and financial investment trends.

Table 4.3: Impact of Climate Change on Pakistan's Economy

Factor	Beta Coefficient (β)	p-value	Impact Direction
Climate Change (Mediator)	-0.62	0.000	Significant Negative Impact
Agricultural Productivity	0.45	0.002	Positive Impact on GDP
Government Policy Support	0.32	0.004	Moderately Positive Impact

In Table 4.3, the impact of climate change on Pakistan's economy and the agricultural sector share in GDP and the economic stability is analyzed.

Finally, Climate Change (Mediator) (-0.62, p=0.000) has a significant negative impact which indicates that climate change constitutes a huge economic burden to Pakistan's agriculture. Extreme weather events, uncertainty in rainfall and temperature fluctuations have reduced the productivity in agriculture leading to a lower contribution of GDP from the sector.

Agricultural Productivity (0.45, p=0.002): A positive effect on the economy, therefore, depicts a scenario where an immediate increase in agricultural yields directly correlates to GDP growth. This implies that enhancing agricultural productivity can enhance Pakistan's economy's resilience to climate change shocks.

Moderate Positive Impact (0.32, p=0.004) means providing policy support has a positive effect on counteracting climate risk, but only helps reduce economic losses but does not completely offset it. And this once again emphasizes the importance of improving climate adaptation policies implementation and financial support for farmers.

4.4 Food Security and Farmers' Income

Agricultural production trends and financial survey response were used to analyze food security, as well as farmers' income.

Table 4.4: Food Security and Farmers' Income Trends

Indicator	2018	2020	2022	2024
Wheat Production (Million Tons)	25.0	24.2	23.5	22.8
Rice Production (Million Tons)	7.5	7.2	6.8	6.3
Farmers' Avg. Annual Income (PKR)	500,000	480,000	460,000	430,000

In Table 4.4, some trends in food security and farmers' income in the past years are highlighted.
Decrease in Wheat Production: 2018 (25.000) million tons to 2018 (22.800) million tons. Harvested oil production fell closely in line with these factors, owing to climate change elements such as erratic rainfall, temperature increase and soil degradation.
The rice production declined from 7.5 million tons in 2018 to 6.3 million tons, which is not a good sign for food security. However, water scarcity and extreme weather conditions in paddy fields are the main cause towards that reduction.
Farmers' Income Decline: In 2018, farmer's income was approximately PKR 500,000 per annum, while for 2019 it came down to PKR 430,000, which defines farmer's condition as worse off with declining income. Increased costs of input, fertilizers and access to water further put pressure on farmers' revenue, which in turn erodes the farmers' life style and leads to lower productivity and hence lower revenue.

4.5 Mediation Analysis – Role of Climate Change

It was required to see whether climate change mediated the relationship between IVs and DVs and for this situation, a structural equation model (SEM) was employed. We confirm that climate change is a very strong mediator, amplifying the negative effect of increase in temperature and soil degradation, and provides for moderating effect of water and technology adoption.

Table 4.5: Mediation Analysis Results

Pathway	Direct Effect (β)	Indirect Effect (β)	Total Effect (β)	Significance
Temperature → Climate Change → Productivity	-0.40	-0.22	-0.62	Significant
Water Availability → Climate Change → Productivity	0.30	0.18	0.48	Significant

In Table 4.5, the mediating role of climate change variables in between the climate change factors and agricultural productivity is considered.
The increase in temperature → the climate change → the productivity (-0.62 total effect): A negative indirect effect (-0.22) implies that climate change worsens the impacts of temperature increase and so worsens agricultural losses.
Climate change (0.28 total effect) → Water Availability → Productivity (0.48 total effect): Water management provides a positive indirect effect (0.18), which means that better water management is able to somewhat offset climate change risks and contributes to agricultural productivity.

Conclusion

This research looked into the effect of climate change on financial development of agriculture sector of Pakistan, focusing on the major risk factors and possible options of resolving them. This study evaluated how the effect of temperature increase, soil degradation, water availability, technology adoption and public policies on agricultural productivity, food security, level of farmers' income, and Pakistan's economy is mediated by climate change.
The results showed that temperature rise and soil degradation have majorly negative impacts to agricultural productivity resulting in declining crop yields, decreasing farm incomes, and growing food insecurity. Rising input costs, water shortages as well as unpredictable weather patterns are making it harder for farmers to keep afloat financially. Since 2018 till 2024, production of wheat and rice has been steadily going down, which emphasizes the necessity of climate adaptation strategies.
On the plus side, agricultural productivity was found to have strong positive effects of adoption of technology and water availability. The research proved that farmers who have access and are using modern farming techniques and improved irrigation systems yield more and are more economic resilient. Yet, government policies played only a moderate role, suggesting that existing agricultural policies and

support systems for farmers have to be improved to effectively counter climate risks.

The mediation analysis validated that climate change worsens the impact of environmental stressors on agricultural decline. The urgent need now is for climate resilient policies, infrastructure investment and financial support for farmers.

Thus, closing, Pakistan needs to focus on climate smart agricultural practices, much stronger policy intervention, better water management, and better connections of farmers to financial resources. Sustainable solutions implemented by Pakistan can help protect the agricultural sector from climate risks, maintain food security and promote the country's long term economic stability as climate continues to challenge.

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