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CLIMATE CHANGE AND FOOD SECURITY: A SPOTLIGHT ON AVAILABILITY CONDITIONS IN PAKISTAN

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ABSTRACT

Extreme weather patterns, including droughts and floods, are a result of Pakistan's present climate crisis and reduce agricultural production. A serious food security issue arose in Pakistan in 2022 as a result of widespread flooding. The achievement of Sustainable Development Goal 2 (SDG-2)—which seeks to eradicate hunger, ensure food security, enhance nutrition, and support sustainable agriculture—is hampered by this in Pakistan. Given this, an econometric model will be used to examine the impact of the changing climate on Pakistan's supply of food. The study will look at data, policy papers, and published works about how environmental degradation affects food safety, specifically "Food Availability" in Pakistan. Conversations with experts are going to be conducted as part of the procedure as well. Given its main findings, the project will provide suggestions to players on climate-smart policies for farming, regenerative cultivation methods, and approaches to mitigate the consequences of greenhouse gas emissions on food security.

Key Words: *Food security, climate-smart agriculture, climate change, Sustainable Development Goal 2*

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1. BACKGROUND OF THE STUDY

Food security, recognized as a fundamental human right, only gained widespread attention in 1974 when it was first coined at the World Food Conference. Initially, the term focused solely on the availability of a well-balanced and sufficient supply of basic food. However, its scope expanded significantly during the World Food Summit in 1996. It came to encompass economic access, physical availability, nutrient intake, good food practices, and diverse diets. Diverse diets involve ensuring the persistent stability of the three dimensions (Food Availability, Food Accessibility, and Food Utilization), but now Food sustainability is also considered as a dimension. In essence, it involves maintaining a consistent and diverse availability of nutrient-rich food and its utilization to enable people to lead healthy lives.

Pakistan has been facing a food security crisis for a long as FAO (2016) reported that Pakistan performed worst as compared to other Southeast Asian countries during 2011-2015. According to the UN World Food Programme (WFP), more than 20% of Pakistan's population is malnourished, and around 45% of children under the age of five are stunted. Pakistan is ranked 92 out of 116 countries whose hunger issue is severe in the Global Hunger Index (GHI) ranking. Pakistan faces problems including undernourishment, deficits in micronutrients, and a lack of safe drinking water. According to the State Bank of Pakistan, it is a highly concerning condition for Pakistan since 36.9% of families are food insecure, and 18.3 % face severe food insecurity.

One of the major factors influencing the food security situation in Pakistan is Climate change which is analyzed in a nutshell by Long-term shifts and changes in temperature, weather patterns, and rainfall phenomenon. According to the Annual 2022 Global Climate Report, the global annual temperature increased at an average rate of 0.08(Degrees Celsius) per decade since 1880. Climate change poses significant risks to development outcomes across various fields, including but not limited to economics, agriculture, health, infrastructure, and social stability. However, the major impact of Climate change is on the food security. Climate change is significantly affecting and is projected to be affecting the agriculture sector of Pakistan in the future as well. As Pakistan is a developing nation with a lack of resources its climate change mitigation strategies are inadequate which is causing severe issues for food security. The nation frequently experiences periods of severe drought followed by destructive floods, which have led to low crop yields, animal losses, damage to irrigation systems, and food shortages in recent years. The monsoon Floods of 2010 were a real image of climate change for Pakistan. It significantly affected the agriculture and livestock sector in Pakistan. According to the FAO agriculture assessment report around 2 million hectares of standing crops were lost or damaged and roughly 1.2 million livestock animals died due to floods. According to the World Bank report on Climate Smart Agriculture in Pakistan, an increase in mean temperature of 1.4 (Degrees Celsius) -3.7 (Degrees Celsius) by 2060 is expected in Pakistan, these changes in temperature and monsoon will cause significant losses to the agriculture sector in Pakistan and hence cause severe food security crises in Pakistan. The study aims to analyze the impact of climate change on the food availability situation in Pakistan by applying an econometric model. Moreover, the intention is to examine the role of the government in addressing food security challenges mainly food availability.

2. LITERATURE REVIEW

Food security is considered a global concern, which is vital for the well-being of every country in this world. Achieving and maintaining food security has been a persistent challenge in Pakistan. Climate change is a primary factor worsening the situation of food security in Pakistan. This literature review will provide an overview of the impact of climate change on the food security situation in Pakistan with more focus on the availability criterion of food security, ongoing interventions, and recent developments in the context of the food security situation in Pakistan concerning climate change.

Tariq et al. (2014) present the results of some studies on the impacts of climate change on wheat and rice in Pakistan focusing on three dimensions of food security namely supply, access, and equity in distribution. The methodology is based on literature. The study shows climate change threatens irrigational capabilities due to glaciers melting, rising temperatures lower crop yield, and water logging and erosion causing degradation of land. It recommends adaptive measures as the remedy.

Muhammad (2013) conducted a literature review from previous studies to understand food security components and identify key policies to deal with food security issues. It assessed climate change in Punjab as being the largest determinant of agricultural production and found out rising temperatures and lower rainfalls affect food production and scarcity. It recommends crop insurance schemes, cash transfers, credit borrowing, and establishing a food bank.

FAO (2019) explores the climate-smart agriculture (CSA) concept that reflects the integration of agriculture development and climate responsiveness. It studies major factors like land use, greenhouse emissions, and nutrition. The document emphasizes the relationship between agriculture and climate change and suggests data-driven models to adopt the right policies. It also urges the need to finance CSA.

Nouman et al. (2021) studied the effect of climate change on major crops in Pakistan.The most influencing climate variables were found to be high temperature, rainfall, and humidity. It suggests government action to solve such issues.

World Bank (2022) presented a climate change brochure that looks at adaptation options and strategies for climate change's impact on food security. It emphasizes the impact of rising temperatures on food security and specifically looks at the micro level, household sector. It expects policies to look after poor households, measure climate change impact, and enhance analytical capacity at the national level for such food security issues.

Sajid et al. (2017) studied how to counter the impact of climate change on Pakistan’s food security. It analyzed that climate change affects agricultural productivity due to less rainfall, glacier melting, and floods and recommended implementing agroecological zones in Punjab, crop diversification, and using appropriate weather forecast information.

Waseem et al. (2022) analyzed that Pakistan has been facing food security in recent years due to flood impacts. Satellite images and data have shown flood effects on agricultural land which has shown drastic damage to the malnourished population in the area. A statistical model has been applied to show the changes in GDP with losses to the nation. Recommend using low-level carbon fuels and renewable energy resources to lower the effect of global warming.

Syed et al. (2021) showed that Pakistan has a high population which is dependent on locally grown crops about 60-70 percent. Climate variation in nature can affect crops which endanger food security. The study has data showing yield reduction due to climate hence it is recommended to use environmental and sustainability methods to help increase the production of yield in the future and use Climate smart agriculture technology.

A study by Munir et al. (2016) highlighted the effects of climate on food security hurt the nation hence the study has a time series data analysis which has shown climate temperature is negative and fertilizers have a positive impact on food security or production. Hence government should produce more dams and water storage or give direct loans or subsidies to farmers so they can produce more crops and provide proper information to educate and make farmer's production to increase.

A report by SDPI (2018) highlights the higher temperatures and reduced water availability wreak havoc on livestock, while climate-related disasters disrupt market access and food supplies. As climate change causes agricultural production to decline, the incomes of agricultural households fall, while food prices rise. When staple foods become prohibitively expensive for the most impoverished, people turn to negative coping strategies – across Pakistan, economic constraints cause households to eat less, to eat less often, and to opt for cheaper, less nutritious foods. It is suggested to use CSA and fertilizers as well as dams to stop flooding and help farmers with water production during droughts.

3. DATA AND METHODOLOGY

The study draws on published reports from various organizations, including the Food and Agriculture Organization, the United Nations, the World Food Program, and the Sustainable Development Policy Institute. In addition, an econometric model was used to examine the correlation between climate change and food security. In this analysis, wheat yield per acre in kilograms serves as a proxy for food security, while climate change is assessed using indicators such as average temperature, precipitation, humidity, and sunshine. These resources are complemented by insights from interviews with officials of the Ministry of National Food Security and Research, which provide valuable first-hand knowledge for a comprehensive understanding of the topic. Food availability is the major component of food security. It addresses the supply side of food security. Total food production determines the total level of food availability in a country, including imports and excluding exports. In some instances, the existing stocks, i.e., remaining food from the previous year, and the food aid from other countries are also accounted for in the calculation of food availability.

Table 1: Production (000 Tonnes)

Food Item Name	2018-2019	2019-2020	2020-2021	2021-2022
Pulses	713.6	662.8	484.9	626.8
Wheat	24349	25248	27464	26208
Rice	7,202	7,414	8,420	9323
Milk	59800	61700	63684	65745

It is evident from Table 1 that the annual production of milk, rice, and pulses is increasing in Pakistan. However, these production levels prove to be insufficient to meet the needs of the country's rapidly growing population. This situation is further exacerbated by supply-side challenges and climatic shifts, worsened by inefficient farming techniques that are not climate-smart. Farah Naz Claimed in her news article that events like the 2010 floods and the recent 2022 flash floods serve as stark examples of the challenges posed by climate change on food availability. Furthermore, severe heat waves, heavy rainfall in the wrong seasons, humidity, and other climatic change impacts the food availability in Pakistan.

The following model is used to study the impact of climate change on food security. To represent food security the current study uses wheat yield per acre in kg as its proxy while climate change is captured by using average temperature, rainfall, humidity, and sunshine. The time period is included as an independent variable to predict the trend. The study uses data on wheat crops from 1981 to 2013 of district Sargodha which is gathered from Pakistan Meteorological Department, Ministry of National Food Security & Research and Pakistan Bureau of Statistics.

The variables can be explained as;

$$Y_i = \alpha_o + \alpha_1 T_t + \alpha_2 Tem\min_t + \alpha_3 Tem\max_t + \alpha_4 Sun_t + \alpha_5 Rain_t + \alpha_6 Hum_t + \nu_t$$

Y= Wheat yield per Acre in kg

α_i = Parameters to be estimated

T= time period

Tempmin=Average yearly minimum temperature (°C) during wheat crop season

Tempmax= Average yearly maximum temperature (°C) during wheat crop season

Rain= Average yearly rainfall (mm) during the wheat crop season

Sun= Average yearly sunshine during the wheat crop season

Hum= Average yearly humidity (%) during wheat crop season

ν_t = Error term

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

The descriptive summary of the variables is given in the following table. This information helps to observe the changes in climatic variables and food availability variables.

Table 1: Descriptive Statistics Result

	MAXT	MINT	RAIN	SUN	YIELD	HUM
Mean	25.70	10.147	0.440	7.439	56.55	60.443
Median	25.84	10.344	0.421	7.470	57.16	60.514
Maximum	27.25	11.060	0.905	7.932	79.08	65.666
Minimum	23.18	8.5702	0.207	6.657	33.07	54.505
Std. Dev.	0.968	0.7032	0.196	0.280	14.39	2.2124

Skewness	-0.625	-0.9155	1.006	-0.714	-0.034	-0.0551
Kurtosis	3.227	2.9911	3.167	3.511	1.762	4.1484
Jarque-Bera	2.220	4.6101	5.614	3.163	2.113	1.8302
Probability	0.329	0.0997	0.060	0.205	0.347	0.4004
Sum	848.40	334.86	14.54	245.5	1866.00	1994.6
Sum Sq. Dev.	29.99	15.827	1.229	2.526	6626.40	156.64
Observations	33	33	33	33	33	33

4.2. Regression Results

Since wheat is Pakistan's most important staple crop, the growing of wheat is the primary focus of the food security programmes. Due to its widespread use as food and its relative affordability as a source for animal feed, wheat is considered significant. Wheat is sown in the winter and harvested in the summer. Wheat grows best at low temperatures, although high temperatures can impede the growth of seedlings. Similar to this, changes in rainfall patterns harm wheat productivity during harvest, which eventually results in a state of food insecurity throughout the nation. It can be seen from the results that rain and sunshine are negatively affecting wheat crops and results are significant. In other words, both climatic variables are reducing wheat production which will create a shortage of wheat resulting in food insecurity. The other two climatic variables humidity and temperature are positively related to wheat production raising wheat yield.

Table 2: Results of Regression Analysis

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-172.0062	154.9739	-1.109904	0.2768
MAXT	6.406077	5.672822	1.129257	0.2687
MINT	6.687968	6.998620	0.955612	0.3477
SUN	-18.09469	10.08208	-1.794737	0.0839
HUM	2.271935	1.488370	1.526459	0.1385
RAIN	-15.23073	13.95653	-1.091298	0.2848
R-squared	0.313589	Mean dependent var		56.55152
Adjusted R-squared	0.186476	S.D. dependent var		14.39010
S.E. of regression	12.97923	Akaike info criterion		8.127544
Sum squared resid	4548.432	Schwarz criterion		8.399636
Log likelihood	-128.1045	Hannan-Quinn criter.		8.219095
F-statistic	2.467009	Durbin-Watson stat		0.854154
Prob(F-statistic)	0.057780			

5. CONCLUSION AND POLICY OPTIONS

We interviewed officials from the Ministry of National Food Security & research and found out that the government of Pakistan has been actively engaged in implementing various schemes to enhance food security in the country. The Pakistan Government is

working on different projects and schemes to target the Food Availability or supply side issues of food in Pakistan while mitigating the impact of climate change.

The Pakistani government introduced the Kissan Package in 2022 to increase agricultural productivity through focused initiatives. About fifteen programs make up this flagship initiative, one of which is Agri-loan disbursement, which makes it simple for farmers to obtain loans and make investments in the agricultural sector to increase productivity. Agri-loan waiver of markup on outstanding loans for subsistence farmers in flood-affected areas is another component of the scheme.

The program also includes trout farming, with a dedicated fund set aside to support trout farming in Pakistan's northern regions. The Productivity Enhancement Scheme is a direct intervention designed to address Pakistan's problems with food availability and meet the global commitment of SDG-2

To handle the issues that climate change presents in several industries, including agriculture, Pakistan developed a National Climate Change Policy. The goal of the strategy is to increase vulnerable communities' and industries'—including agriculture's—ability to adapt to the negative effects of climate change.

Climate Change Act of 2016: This law establishes a legal foundation for actions about climate change. It fosters the adoption of climate-smart practices and highlights the integration of climate change issues into numerous sectors, including agriculture.

Pakistan is facing severe Climatic effects that are affecting the food security situation in Pakistan, especially the food Availability criterion, this needs to be dealt with climate-smart practices to achieve a food-secure Pakistan with proper food availability in Pakistan.

To achieve the availability criterion of food security in Pakistan and mitigate the impact of Climate change following Policies need to be considered.

Becoming modern and highly aggrotech is very crucial to achieving the desired availability of food in Pakistan.

Argo technologies (Climate-smart technologies) need to be disseminated at the grassroots level where local farmers and producers have easy access to these technologies and can implement these technologies in their farming practice which will help to gain maximum impact as far as productivity is concerned which is related to food availability

The Agri sector doesn't seem to be very lucrative and very less incentives are available for the Private sector; The Government needs to work hard to make this sector profitable through incentives so the private sector is attracted who can then invest at large scale to achieve Food Secure Pakistan with very little impact of climate change on it.

The government's investment in modern agriculture and dissemination of its benefits at the grassroots level can play a vital role in mitigating the adverse impacts of climatic changes on the agriculture sector. Such initiatives can enhance the resilience of Pakistan's agriculture sector and pave the way for a sustainable future achieving the international commitment of SDG-2 Zero Hunger.

The academic sector needs to highly participate in the research related to climate-smart agriculture which can help Pakistan by their research to be very up to date regarding different methods to mitigate the impact of climate change on Food security in Pakistan.

It is important to establish a comprehensive agricultural mapping system in Pakistan. Such a system would facilitate the identification of lands suitable for specific uses, ensuring optimal allocation of resources and development of the agricultural sector and protecting the crops from harnessing effects of climate change.

To achieve Climate Smart Agriculture in Pakistan, it is imperative to adopt appropriate environmental laws and develop consistent, clear policy guidelines. By doing so, we can ensure a sustainable and responsible approach to agriculture that benefits both our country and the global community.

As we live in a Globalized world, we need to develop region-specific policies to tackle the impact of climate change because every region will be having different issues related to climate change. These policies should be tailored to local conditions and risks to mitigate negative effects while promoting sustainable food security.

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