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Assessing the Socio-Economic Impact of Climate Change on Rural Farmers in District Kohat, Khyber Pakhtunkhwa

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ABSTRACT

Climate change is increasingly recognized as a socio-economic stressor, particularly for smallholder farming communities whose livelihoods depend directly on natural resources. This study examined the socio-economic effects of climate change on farmers in District Kohat. Using a cross-sectional research design, data were collected from farming households and analyzed through descriptive statistics and bivariate Tau-C correlation analysis. Inferential analysis revealed statistically significant associations between climate change and socio-economic well-being across all tested variables ($p < 0.000$). A strong relationship was found between climate change and household food insecurity (Tau-C = 0.329, $p < 0.000$), followed by income loss due to crop failure (Tau-C = 0.310, $p < 0.000$) and rising poverty levels among farmers (Tau-C = 0.289, $p < 0.000$). Agricultural productivity (Tau-C = 0.283, $p < 0.000$) and government support inadequacy (Tau-C = 0.223, $p < 0.000$) also showed significant associations with socio-economic impact. These findings demonstrate that climate change is a compounding socio-economic stressor affecting income, food access, and employment patterns among rural farming households in Kohat. The government needs to create agricultural input schemes to help lower the financial burden on farmers in rural areas, resulting from the increasing cost of farm inputs caused by climate change.

Keywords: *Climate Change, Rural Farmers, Livelihood, Food Insecurity, Poverty, Agriculture, Unemployment.*

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Introduction

Climate change is not only changing the climate and weather but also communities that are directly impacted by the alteration of the natural resources they depend on for their socio-economic development. Together, agriculture and land use contribute about one-fifth of the world's greenhouse gas emissions, and agriculture is also among the most impacted by the changing climate (Coolfarm, 2024). These communities are especially vulnerable to the impacts of global warming due to the dual nature of rural agriculture, which contributes relatively few greenhouse gas emissions but experiences disproportionately large impacts.

The Intergovernmental Panel on Climate Change (IPCC) has concluded with high confidence that the climate hazards are already impacting the livelihood resources critical to the rural poor, including land, water, labour and social capital. By 2030, over 100 million people could be pushed into extreme poverty as a result of climate impacts in a high-inequality development pathway (IPCC, 2022). This burden falls on developing countries, which account for a negligible proportion of global emissions, despite developed countries producing the bulk of emissions. Smallholder rain-fed agriculture is very common in South Asia, and poverty is widespread, while systems are both ecological and economic and are subject to climatic shocks. Extreme weather events such as flash floods, long droughts, erratic monsoons, and others have been reported to be associated with the overall trend of anthropogenic climate change (Ali & Erenstein, 2017).

Pakistan is a case in point. Pakistan is one of the most climate-risk-prone countries, and in the last 20 years, it has suffered greatly from climate events and has seen an increase in temperature and very irregular precipitation in the last century. Many people, especially in Pakistan, depend entirely on agriculture and livestock husbandry for their livelihood, and any agricultural disruption quickly turns into a household-level economic crisis. In recent years, floods in KP have affected millions of people and destroyed large areas of cultivable land, showing how a single climatic event can compromise the stability of the rural economy for decades (Yousafzai et al., 2022). Competition over land and natural resources already affects rural livelihoods in Khyber Pakhtunkhwa, in some instances transformed into a cycle of conflict in areas of the province, impacting schooling, mobility, and community unity (Muhammad et al., 2025).

Climate change worsens the economic burden of agricultural production. Rural farmers often face high costs as they try to adjust their agricultural methods in response to a changing environment, including investments in irrigation improvements when water becomes available and changes in farming technologies. These adaptation initiatives, although indispensable, place financial pressure on households, which at the same time face reduced productivity and income volatility (Nasir et al., 2019). Given poor access to credit and cheap technology by many rural producers, the consequent rise in production costs is also a contributing factor to growing socio-economic disparities in rural areas.

Research Objective

To investigate the socio-economic impacts (daily life, food insecurity, poverty, agriculture, and unemployment) of climate change on rural farmers.

Hypothesis

H_1: There is a significant association between socio-economic impacts (daily life, food insecurity, poverty, agriculture, and unemployment) of climate change on rural farmers

H_0: There is no significant association between socio-economic impacts (daily life, food insecurity, poverty, agriculture, and unemployment) of climate change on rural farmers

Research Method

The study's research design used a cross-sectional technique, sometimes referred to as 'one-shot' or 'status' studies, which is the most prevalent methodology in the social sciences. Creswell (2014) claims that this approach is most suited for cross-sectional population studies that ascertain the prevalence of a phenomenon, circumstance, issue, problem, or attitude. This approach helps obtain a thorough picture of the situation as it stands at the time of the study (Kumar, 2012).

Universe of the Study

The study was conducted in District Kohat, located in the southern part of Khyber Pakhtunkhwa. It comprised three tehsils, namely Kohat, Lachi, and Gumbat. The district has a semi-arid climate with irregular rainfall, making agriculture highly dependent on seasonal patterns. Most of the rural population relies on farming and livestock for their livelihood. This makes them more susceptible to the effects of climate change (Pakistan Bureau of Statistics, 2023).

Proportional Allocation of Sample Respondents

Sr. No	Tehsils	Registered Farmers	Sample size
1	Tehsil Kohat	5144	207
2	Tehsil Gumbat	1808	73
3	Tehsil Lachi	2206	88
Total		**9158**	**368**

Source: *Office of the Agriculture Department, Kohat (2023).*

Sampling Procedure

The sample size may be optimal. It may cover all the areas where the researcher wants to conduct his/her research (Kothari, 2004). According to the 2023 Census, the number of rural farmers in the district of Kohat is 9158. According to Sekaran (2003), a sample size table calculated with a 5% margin of error and a 95% confidence level indicates that a sample of 368 respondents is sufficient.

Data Collection Tool

The interview guide encompasses all study variables used for data collection. Further, the responses were recorded at three levels of the Likert scale, i.e., Agree, Disagree, and Neutral**.** The tools for the data collection guide were pretested with a small group of the target population to recognize doubts or inconsistencies. Based on the findings from this pilot survey, necessary changes were made to improve clarity and accuracy (Joshi et al., 2015). The reliability test was taken into consideration after the primary data collection, which is called the split-half reliability test, as introduced by Spearman and Brown (1910). The reliability of the current study was measured as 0.773, which was considered sufficient by Nunnally (1978). The chi-square test was employed to ascertain the relationship between the research variables. The Chi-square test values were computed using the formula provided by Kothari (2004). Additionally, the Tau-C directional test was applied to determine the direction of the results.

Chi Square formula ……………………………… $x^2 = \sum \frac{(O_i - E_i)^2}{E_i}$

Data Analysis

After compiling all primary information, the data were entered into SPSS and coded and analyzed at a univariate level with frequency and percentage, as well as at a bivariate level through chi-square application with a Tau-C directional test. All the results were discussed with appropriate explanations and relevant literature from the study (McCall & Kagan, 1970).

Results and Discussions

To test the association between the two variables, the researchers carried out bivariate analysis; the relationship between the independent variable, climate change, and the dependent variable, socio-economic impacts of climate change on rural farmers, was measured using the chi-square statistic and Tau-C test. In this context, the statement "Impact on Agricultural Productivity" shows a statistically significant and positive correlation with socio-economic impacts ($P < 0.000$, Tau-c = 0.283). The moderate positive association is consistent with the idea that climate change is a significant factor influencing agricultural productivity and is impacting the economic base of rural farming household.

In support of the above findings, a similar study conducted by Lobell et al. (2011) shows climate variability has a significant impact on agricultural output and also makes agricultural households more vulnerable due to reduced household income, disrupted crop production, and loss of food security (Morton, 2007). At the same time, changing rainfall patterns and increased temperatures have been suggested as important drivers of decreased crop yields and increased production risk, particularly for rain-fed agricultural systems that are highly dependent on seasonal rainfall for their livelihood.

Likewise, the association between the statement "Rainfall Effect on Crop Yields" and the socio-economic impacts is extremely significant and positive ($P < 0.000$, Tau-C = 0.239), highlighting the fact that irregular and unpredictable rainfall is a continuous and notable problem that impacts crop yields and, consequently, the socio-economic situation of the rural farmers who rely entirely on seasonal rainfall for their living.

One of the notable and well-reported effects is the decrease in cool-season rainfall in Pakistan over recent times (the late twentieth century). This decline has directly affected the yield of wheat, barley and canola crops, which are perceived to be the major element of farm income in Khyber Pakhtunkhwa. Empirical studies have revealed that the trends in climatic conditions experienced since 1990 lowered the average returns on farms in certain areas because of the rise in the number of drought events and a decline in production. Less precipitation, in its turn, leads to lower crop yields and heightened risks of production, which compel farmers to change their planting times and inputs, which, in most cases, are associated with more expensive production (Hochman et al., 2017).

The second statement, "Rising Temperature/Farming Difficulty" ($P < 0.000$, Tau-C = 0.161), illustrates a very significant and moderately positive correlation; heat stress associated with rising temperatures is difficult and hinders agricultural activities, decreasing the overall efficiency and productivity of rural farming activities. The association between climate change and "increased farming input costs" is very significant and positive ($P < 0.000$, Tau-C = 0.147). The Tau-C value indicates a somewhat lower correlation with other statements, but it is statistically significant and demonstrates an increase in input costs such as seed, fertilizer, and watering for rural farmers as a result of climate change, adding to their financial burden.

The economic cost of agricultural production is aggravated by climate change. The rural farmers are usually at a great expense since they strive to adapt their farming techniques to the changing environment, which involves making irrigation upgrades when the water supply arrives and making use of new farming technologies. These adaptation initiatives, although indispensable, place financial pressure on households, which at the same time face reduced productivity and income volatility (Nasir et al., 2019).

The relationship for "Water Scarcity/Farming Impact" is very high and significant ($P < 0.000$, Tau-C = 0.172), which shows that changes in water scarcity are a direct effect of changes in climate patterns and are a significant challenge to continuous farming and farming productivity in the study area. The socio-economic vulnerability of the rural farming households is high because the statement "Crop Failure/Household Income Loss" has a very high correlation and is moderately significant (Tau-C = 0.310, $P < 0.000$), meaning that crop failure due to climate change has a direct and significant negative impact on household income, worsening livelihood conditions and food security for rural farming households.

In support of the above findings of the research study, similar data were discovered by Kirby et al. (2014); water scarcity is arguably the most important socioeconomic aspect of climatic perturbation for Australian agrarians, since the scarcity of water resources is a direct impinging factor on agricultural viability and rural life. The Murray-Darling Basin, which supports a significant share of irrigated agricultural production, has suffered from reduced inflows progressively coupled with more acute competition between agricultural, environmental, and urban water stakeholders.

Reduced water allocations directly limit crop decisions and often result in farmers having to abandon high-value but more water-intensive crops like rice and cotton in favor of crops that require less water, resulting in lower farm revenues and changes in the structure of employment within the region. The relationship between the statement "Household Food

Insecurity" and the socio-economic impacts is highly significant and positive ($P < 0.000$, Tau-C = 0.329), showing that climate change is a significant factor in causing food insecurity in rural farmers' households.

This finding underscores the link between climate-induced disruptions to agricultural production and insufficient household-level access to food, exacerbating the socio-economic vulnerability of farming households. The relationship between the statement "Difficulty Meeting Daily Needs" and the indicator is statistically significant, with a moderate correlation ($P < 0.000$, Tau-C = 0.191), showing that the impacts of climate change are seriously affecting the capacity of household farming in rural communities to meet their daily needs.

The IPCC, (2022) notes that since rural households are dependent on agricultural products as a source of subsistence and market sale, the instability in climate is directly converted into economic vulnerability, food insecurity, and social instability. Having already undermined the sustainability of agriculture in many parts of Asia, climate change is expected to add to the ongoing loss of cropping and livestock diversity in the region, especially in South Asia and Southeast Asia, including the Pacific islands, where adaptive capacity and institutional support are uneven at this time.

This association is evidence of the general socio-economic burden of climate change, as agricultural income and productivity both suffer; overall livelihoods and economic resilience in rural farming communities are reduced. The statement "Farmers Seeking Alternative Jobs" shows a very strong and positive correlation with socio-economic impacts ($P < 0.000$, Tau-C = 0.154), implying that some farmers in the community are being pushed away from farming towards other livelihoods due to climate change. The discovery echoes the rising job losses within farming communities due to the increasing unsustainability and low productivity of farming, caused by climate pressures.

The above finding is further supported by the study of Bryan et al. (2009): the migration of households to urban centers or work-seeking has become increasingly common in areas affected by recurrent climate shocks. Empirical studies on adaptation practices in Ethiopia and South Asia show that households are diversifying their income sources to mitigate the effects of climate-induced losses in the agriculture sector as well as job opportunities in the market. The statement "Rising Poverty among Farmers" shows an extremely high and moderately positive relationship ($P < 0.000$, Tau-C = 0.289), thus indicating that climate variability is a significant factor in the rise of poverty among rural farming households. This association highlights the fact that climate variability is not only an environmental issue but also a socio-economic problem, amplifying inequality and financial difficulties among farmers.

Further support for the above finding can be found in the study conducted by Nasir et al. (2019). The socioeconomic effects of climate change also led to greater poverty and vulnerability to economic shocks for rural households. Research from the cotton-wheat cropping system in Pakistan highlights that, due to climate-induced yield declines, net economic impacts on farmers may be negative, increasing the chance of poverty in agrarian communities. These economic risks are also exacerbated by poor access to social safety nets, insurance, and formal financial services that can act as a buffer against climate shocks. Similar data contain institutional gaps in which it has been observed that institutional frameworks in the formerly FATA districts are lacking, and the front-line actors can manage the structural pressures informally without an institutional framework being present (Muhammad et al., 2025).

Also, a consistent and significant risk to the livelihoods of the rural farmers is extreme weather events (drought/flood), as indicated by the statement "Extreme Weather/Livelihood Impact" ($P < 0.000$, Tau-c = 0.141). The findings will again show that the increase in the number and intensity of such occurrences is greatly affecting agricultural production and income generation, and this is further compromising the economic stability of farming families.

The correlation reflected in the statement "Reduced Agricultural Employment" is very significant and positive ($P < 0.000$, Tau-C = 0.166), meaning that climate change is causing a visible decrease in employment opportunities in agriculture in the study area. This association indicates that lower productivity and food losses due to climate change have broader socio-economic impacts, reducing the need for the agricultural workforce and decreasing farmers' livelihoods.

The statement "Impact on Livestock Production" has a very significant and positive relationship (P < 0.000, Tau-C = 0.157), indicating that climate change is a real issue in livestock production for rural farming households. This association not only indicates the socio-economic burden of climate change on agriculture but also on the livelihoods of farming families, as livestock is considered a source of livelihood and food security. The statement "Rural-to-Urban Migration" has a very significant and moderately positive correlation with socio-economic impacts (P < 0.000, Tau-C = 0.111), indicating that climate change is indeed a meaningful influencing factor on the rural-to-urban migration of farming communities. Finally, there is a very strong positive association between "Insufficient Government Support" and the overall socio-economic vulnerability of rural farmers (P < 0.000, Tau-C = 0.223), with a perceived lack of government support being meaningfully correlated with overall socio-economic vulnerability.

Consistent with the above finding, a similar study was conducted by Bryan et al. (2009); a salient determinant that adds to the vulnerability of the rural agrarian producer is the loss of livestock and degradation of grazing land, which in turn erodes the economic resilience of farming households. African drylands, for example, face growing land desertification driven by climate change and poor land-use practices, which reduces soil fertility and pasture quality. As livestock often form a source of income and part of food security, losses from climate impacts simultaneously affect various aspects of rural livelihood. The migration of households to urban centers or work-seeking has become increasingly common in areas affected by recurrent climate shocks. Empirical studies on adaptation practices in Ethiopia and South Asia show that households are diversifying their income sources to mitigate the effects of climate-induced losses in agriculture. The association indicates that climate pressures are making agriculture less viable, forcing rural farmers to leave their farms and find better opportunities.

Table-2: *Association Between Climate Change and Socio-Economic Impact on Rural Farmers*

Statements		**Socio-economic**				**Chi-square** χ^2
	Attitude	High level	Moderate level	Low level	**Total**	
Impact on Agricultural Productivity	Agree	174	56	12	242	$\chi^2 = 63.578^a$ ($p<0.000$)
	Neutral	4	10	4	18	Tau -C(0.283)
	Disagree	33	62	13	108	
	Total	211	128	29	368	
Rainfall Effect on Crop Yields	Agree	193	75	18	286	$\chi^2 = 55.801^a$($p<0.000$)
	Neutral	14	34	6	54	Tau-C (0.239)
	Disagree	4	19	5	28	
	Total	211	128	29	368	
Rising Temperature/Farming Difficulty	Agree	191	87	21	299	$\chi^2 = 30.826^a$ ($p<0.000$)
	Neutral	16	26	4	46	Tau-C (0.161)
	Disagree	4	15	4	23	
	Total	211	128	29	368	

Increased Farming Input Costs	Agree	188	84	23	295	χ^2=35.432[a] (p<0.000) Tau-C (0.147)
	Neutral	23	41	4	68	
	Disagree	0	3	2	5	
	Total	211	128	29	368	
Water Scarcity/Farming Impact	Agree	179	76	20	275	χ^2=29.634[a] (p<0.000) Tau-C (0.172)
	Neutral	23	30	5	58	
	Disagree	9	22	4	35	
	Total	211	128	29	368	
Crop Failure/Household Income Loss	Agree	188	71	9	268	χ^2=76.640[a] (p<0.000) Tau-C (0.310)
	Neutral	15	27	8	50	
	Disagree	8	30	12	50	
	Total	211	128	29	368	
Household Food Insecurity	Agree	189	58	13	260	χ^2=90.762[a] (p<0.000) Tau-C (0.329)
	Neutral	13	28	8	49	
	Disagree	8	42	8	58	
	Total	211	128	29	368	
Difficulty Meeting Daily Needs	Agree	195	85	19	299	χ^2=44.753[a] (p<0.000) Tau-C (0.191)
	Neutral	13	42	9	64	
	Disagree	3	1	1	5	
	Total	211	128	29	368	
Farmers Seeking Alternative Jobs	Agree	197	94	20	311	χ^2=33.457[a] (p<0.000) Tau-C (0.154)
	Neutral	2	5	3	10	
	Disagree	12	29	6	47	
	Total	211	128	29	368	
Rising Poverty Among Farmers	Agree	191	64	16	271	χ^2=80.054[a] (p<0.000) Tau-C (0.289)
	Neutral	14	28	9	51	
	Disagree	6	36	4	46	
	Total	211	128	29	368	
Extreme Weather/Livelihood Impact	Agree	189	85	23	297	χ^2=28.331[a] (p<0.000) Tau-C (0.141)
	Neutral	4	8	2	14	
	Disagree	18	35	4	57	
	Total	211	128	29	368	
Reduced Agricultural Employment	Agree	190	86	20	296	χ^2=30.922[a](p<0.000) Tau-C (0.166)
	Neutral	6	6	2	14	
	Disagree	15	36	7	58	
	Total	211	128	29	368	

Impact on Livestock Production	Agree	190	96	16	302	χ^2=31.291[a] (p<0.000) Tau-C (0.157)
	Neutral	6	6	1	13	
	Disagree	15	26	12	53	
	Total	211	128	29	368	
Rural-to-Urban Migration	Agree	195	96	24	315	χ^2=20.585[a] (p<0.000) Tau-C (0.111)
	Neutral	1	3	0	4	
	Disagree	15	29	5	49	
	Total	211	128	29	368	
Insufficient government support	Agree	189	78	16	283	χ^2=45.162[a] (p<0.000) Tau-C= (0.223)
	Neutral	7	16	4	27	
	Disagree	15	34	9	58	
	Total	211	128	29	368	

Conclusions

This study aimed to investigate the socio-economic impacts of climate change on rural farming households in District Kohat, KP, across five interrelated fields of daily life: food security, poverty, agricultural productivity, and unemployment. The results confirm that climate change is not an abstract or distant worry for these communities but a lived reality. Most respondents indicated increased occurrences of droughts, inconsistent rainfall, and intensified extreme weather events, as well as increased challenges in planning and executing farming operations.

The statistical analysis further showed that these climatic changes are significantly associated with the socio-economic well-being of farming households. Climate change was more strongly correlated with measures of household food insecurity and income loss from crop failure as well as with increasing poverty, suggesting that the impacts of climate change on rural livelihoods are multi-faceted rather than single. Agricultural productivity and the government's lack of support were also identified as important factors.

Conflict of Interest

The authors showed no conflict of interest.

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