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FARMERS PERCEPTION OF CLIMATE CHANGE AND ITS IMPACT ON THE PRODUCTION OF MAIN CROPS IN THE BALOCHISTAN PROVINCE OF PAKISTAN

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ABSTRACT

This study was designed to investigate farmers' perception of climate change and its impact on major crop production in Balochistan and to forward policy recommendations. A multistage sampling technique was used for the selection of 120 sampled farmers from 3 main agriculture districts-Loralai, Killa Saifullah, and JaffarAbad. A well-structured questionnaire was used to collect data from sampled farmers. Descriptive statistical techniques such as mean, mode, percentages, frequency, and standard deviations were calculated to analyze data on households' socioeconomic characteristics and their response to different climatic factors and technology adaptation questions for climate change. Results reveal that the sampled farmers correctly perceived decreased rainfall, increased temperature, and frequent drought in the study area and how changes in these factors have affected the availability of groundwater and changes in winter and summer seasons during the last thirty years. An increase in temperature and drought resulted decrease in the production of wheat and rice in both irrigated and non-irrigated ecology; while in the case of maize, the production increased in irrigated ecology. The reduced winter and long summer seasons have a negative impact on wheat production and a positive impact on the production of maize because farmers are now growing 2-3 crops of maize per season. The government should invest in research and development of crop varieties that are more resilient to temperature increases, low humidity, and drought conditions, particularly for wheat and rice.

Keywords: Climate Change, Climate Change Perception, Rainfall Intensity, Temperature, Irrigated Ecology, Balochistan, Pakistan.

INTRODUCTION

Climate change has globally affected various sectors, raising significant concerns for the economic systems of upland regions (Kohler and Maseli 2009). There is a documented increase in unpredictable precipitation, elevated temperatures, and rising sea levels worldwide in recent years (Sarker et al. 2014; Li et al. 2019), and further increases are anticipated in the near future (Field et al. 2012). The economic impact of climate change, particularly due to rising temperatures, is highlighted, leading to soil degradation, decreased crop yields, and food insecurity in countries (Ozturk 2017; Fahad and Wang 2020; Knox et al. 2012; Giri et al. 2021).

One of the most serious risks to the long-term viability of life on Earth is the rapidly evolving climate. Global warming is one of the leading causes of environmental damage. The increased discharge of Greenhouse Gas (GHG) emissions into our outer atmosphere as a result of fossil fuel combustion raises the average temperature of the Earth while also contaminating the air. Climate change has an impact on both human life and the economy by changing Earth's climatic systems, causing floods, famines, droughts, and cyclones, among other natural calamities. Climate change is predicted to have far-reaching consequences in Pakistan, including decreased agricultural output, increased variability in water supply, increased coastline erosion and seawater incursion, and an increase in the frequency of extreme weather events (Pakistan Economic Survey, 2020).

Because of its geographical location, Pakistan has been recognised as one of the top ten countries most affected by climate change over the last two decades by German Watch. According to the Global Climate Risk Index annual report for 2020, Pakistan lost 0.53 percent per unit GDP, sustained economic losses of US$ 3792.52 million, and experienced 152 extreme weather events between 1999 and 2018. Similar to this, ADB analysis reveals that the socioeconomic consequences of environmental degradation are significant, with climate adaptation demands ranging from $7 billion to $14 billion per year. (ADB. 2017). Climate variability and weather projections in developing regions suggest a heightened sensitivity to climate change (McCarthy et al. 2001). Because of their limited adaptive capacity, lower subsistence farmers and rural communes are particularly vulnerable to climate change (Kurukulasuriya and Rosenthal, 2013). The impoverished agricultural/rural farm households' perception of climatic fluctuations is necessary for developing risk-mitigation strategies to deal with climatic threats and risks. According to the Intergovernmental Panel on Climate Change's 2014 report, climatic changes are expected to have a bigger impact on agriculture and socioeconomic growth.

Agriculture is the backbone of Pakistan's economy, and it has been negatively impacted by climate change. Climate change can disrupt food availability, restrict access to food, and degrade food quality. Projected temperature increases, changes in precipitation patterns, changes in extreme weather events, and water scarcity may all result in lower agricultural productivity. Crop simulation model-based studies show significant declines in wheat, rice, and maize yields in Pakistan's desert, semi-arid, and rain-fed areas under various Intergovernmental Panel on Climate Change (IPCC) scenarios by the middle and end of the century.

Climate change is mostly caused by human activity, notably greenhouse gas emissions into the atmosphere (McMichael et al. 2003). As a result, climate change is causing a variety of risks on Earth's surface, including droughts, excessive precipitation, heat waves, and unprecedented tropical cyclones (Woodruff et al., 2006).

In recent years, Pakistan has been very vulnerable to climate risks, which have severely impacted agricultural production, ecosystems, farm households' livelihoods, and food security (Akhtar et al. 2019; Saeed et al. 2012). Pakistan ranks seventh among extremely vulnerable developing regions due to extreme weather occurrences, insufficient infrastructure, and inadequate adaption strategies (Schilling et al., 2013).

Baluchistan, Pakistan's largest but least populous province, is facing water scarcity-related difficulties. Baluchistan is divided into four major ecoregions, ranging from semi-arid desert to arid zone.

Table 1: Area Production and Yield for Balochistan's Major Cereal Crops

Crops	Area (Hectares)		Production (Tons)		Yield (Kg/Ha)	
	2017-2018	2018-2019	2017-2018	2018-2019	2017-2018	2018-2019
Wheat	394443	389547	935375	865299	2371	2221
Rice	169803	153520	553828	498143	3262	3245
Maize	2935	2750	1823	2798	621	1017

Source: Agricultural Statistics of Baluchistan (2017-2019).

Three main crops, wheat, maize, and rice, are the main Kharif and Rabi season cereals and staple food for local people. The table.1 indicates the information on the area, production, and yield of major cereal crops in Balochistan for the agricultural seasons of 2017-2018 and 2018-2019. For wheat, the cultivated area decreased slightly from 394,443 hectares to 389,547 hectares, leading to a decline in production from 935,375 tons to 865,299 tons. Similarly, the yield per hectare also decreased from 2,371 kg to 2,221 kg. In the case of rice, both the area and production experienced a decrease, with the area declining from 169,803 hectares to 153,520 hectares and production dropping from 553,828 tons to 498,143 tons. Despite this, the yield remained relatively stable, decreasing only slightly from 3,262 kg to 3,245 kg per hectare. Maize, on the other hand, saw a decrease in both area and production, with the yield per hectare increasing from 621 kg to 1,017 kg, reflecting a potential shift in cultivation practices or crop management strategies.

In light of the ongoing challenges posed by climate change, the study holds immense relevance. As climate change continues to impact agriculture in Balochistan, finding solutions to mitigate its effects becomes a matter of utmost importance. More research work is required to investigate farmers' perception of climate change, its impact on major crops, and what they consider necessary for effective adoption. To fill out this research gap this study is designed with the following objectives.

Objectives of the study:

1. To investigate farmers' perception of climate change and its impact on major crop production in Balochistan.
2. To forward policy recommendations based on the findings of the study.

LITERATURE REVIEW

The literature review has unearthed a mass of valuable understandings closely related to the main topic, Farmers perception of climate change and its impact on the production of main crops in the balochistan province of pakistan. The findings of the relevant studies are presented coherently and continuously. Rehmat et al. (2019) conducted a study in Baluchistan that included three districts and 384 respondents and examined the influence of climate change on main crops. Using SPSS, the study discovered a considerable decline in farmed areas, particularly hurting wheat and maize by 6.18%. This loss, which occurred during the last 15 years, was attributed to a reduction in irrigation water. The survey revealed farmers' financial challenges, as well as a lack of technology expertise and widespread water issues. The authors suggested starting training programs to promote climate change knowledge, lobbying for dams to solve water storage, and emphasizing the importance of extension services in agricultural areas. Sommer et al. (2013) investigated the influence of climate change on agriculture in Central Asia, specifically Kazakhstan, Kyrgyzstan, Uzbekistan, and Tajikistan. The Crop System model is used to measure the growth and production of 14 wheat cultivars across 18 agroecological zones in this study. Despite a 12% average increase in wheat yields across 14 of 18 sites, there are differences between sites, soils, types, and management strategies. Temperature rise has a considerable impact on yields, but precipitation improves rainfed conditions. Elevated atmospheric CO_2 improves transpiration efficiency, minimizing the requirement for additional irrigation. Simulations reveal concerns such as floral sterility and reduced output in specific places as a result of higher temperatures during flowering. The study calls for adaptive methods, such as changing sowing dates, to mitigate climate change consequences and increase productivity. Malla et al. (2008) proposed research that emphasized the need to limit CO_2 and greenhouse gas growth in climate change, which affects agriculture, forestry, human health, biodiversity, snow cover, and mountain ecosystems. A considerable 1.8°C temperature rise was documented between 1975 and 2006, averaging 0.06°C each year. According to Khumaltar's research, rice and wheat yields increased by 26.6% and 18.4% when CO_2 levels doubled, respectively, and by 17.1% and 8.6% as temperatures rose. Using the DSSAT model at NARC, positive benefits on rice and wheat yields were detected. To mitigate the effects, reduce untold natural calamities and miseries due to recent erratic weather patterns. Kingra (2016) investigated long-term climate variability in Ludhiana during the wheat growing season (1970-71 to 2014-15). The study found a considerable increase in the lowest temperature at a rate of 0.06°C each year. The study found that lower lowest temperatures, relative humidity, rainfall, and fewer rainy days during wheat's reproductive growth period (February and March) were favorable circumstances for better grain output. Multiple regression models were used and wheat production accounted for 81% of the variation in productivity. Verification of the model over three years revealed a small underestimating of wheat yield, ranging from 4-8%. Attri & Rathore (2003) addressed global climate change and its impact on world food security, particularly in northwest India. They used dynamic simulation models to quantify the effects of temperature and CO_2 changes on wheat growth and yields. Climate change scenarios projected for the middle of the century were considered, and adaptation measures such as altering sowing dates and genotype selection were explored. Notably, a 10-day delay in sowing for normally-sown cultivars and an advancement by 10 days for late-sown cultivars proved effective in mitigating potential yield reductions under modified climate conditions. Hozayn & Abd El-Monem (2010) focused on the vulnerability of agriculture to weather and climate, conducting a field experiment in Shalkan Province, Kaluobia Governorate, Egypt. Their findings revealed that delayed sowing significantly reduced biological and economic yield, affecting spike characteristics and grain weight. Notably, the application of 2.5 mM of arginine mitigated these effects, resulting in substantial increases in economic yield under normal conditions and delayed sowing by 30 and 60 days. The study suggests that arginine could serve as a potential solution to alleviate the adverse impact of climate change on wheat cultivation in semi-arid regions, particularly in the context of irrigated agriculture. Magrin et al. (2009) investigated the influence of historical and future climate changes on wheat productivity in Argentina's Pampas region. the researchers determined that each degree Celsius of temperature rise could potentially reduce wheat yields by 7.5%. The study projected that anticipated CO_2 effects, particularly at a concentration of 550 ppm, might completely counterbalance the negative impact on wheat yields caused by a 2.5°C temperature increase. In the absence of considering CO_2 effects, rainfed wheat yields were estimated to decline by 4% by the end of the 21st century (2080). he findings suggest that adjusting planting dates could serve as a strategic approach to leverage extended frost-free periods resulting from evolving environmental conditions. Harrison et al. (1996) conducted research on climatic variables, focusing on rainfall, maximum and minimum temperatures, spanning from 1971 to 2010 in the Hisar region, Haryana. Analysis revealed an average annual rainfall of 460.8 mm over 27 rainy days. Notably, the variability of annual rainfall increased from 34% in the 1971-1980 period to 40% in 1991-2000, particularly impacting winter, summer, and post-monsoon seasons. The study highlighted a concerning maximum temperature rise of 1.4°C in February and 1.2°C in March, posing risks to rabi crops. These findings underscore the significant impact of climatic fluctuations on crop growth and yield. Harrison and Butterfield (1996) developed spatially explicit crop models to study the regional impacts of climate change, successfully capturing current spatial variability in observed phenology and yield. Applying climate change scenarios to wheat and sunflower productivity, the models predicted increased wheat yields across Europe, with the smallest increases and largest decreases in sunflowers occurring in western Europe. The UK Meteorological Office's transient experiment forecasted a rise in winter wheat yields by 0.2 t ha-' decade-' up to the 2020s and 0.36 t ha-' decade-' beyond. Sunflowers were projected to experience a decrease of 0.05 t ha-' decade-' up to the 2020s, followed by an increase of 0.05 t ha-' decade-'. These insights highlight potential regional variations in crop yields due to climate change. Miah et al. (2014) assessed the economic implications of climate change on wheat production in Bangladesh through the Ricardian approach. Utilizing panel data on wheat yield and climate variables, the study revealed significant impacts of various climate factors on wheat production income. Notably, a marginal temperature increase in January and February resulted in substantial reductions in net revenue per hectare. The research employed predictions from five Global Circulation Models (GCM) under two IPCC emission scenarios, indicating mixed impacts on net revenues. For 2050, the study emphasized the importance of accurate predictions, as net revenue outcomes varied based on different climate model scenarios, emphasizing the need for precise climate change impact assessments in future projections. Kang et al.(2009) conducted the assessment on the climate change impacts on crop productivity using climate, water, and crop yield models. They emphasized that future climate projections benefit from higher spatial resolution in climate change models. Stochastic projections from multiple climate models are crucial for understanding uncertainties and formulating risk management strategies. Projections indicate varying impacts on crop yields across regions, with some experiencing increases while others face decreases, dependent on latitude and irrigation practices. Reduced water availability in the future may impact crop production, with soils of higher water-holding capacity mitigating drought effects. Despite potential increases in total crop production through expanded irrigation, there are concerns about potential degradation of food and environmental quality due to rising temperatures and precipitation fluctuations. Knox et al.(2012) conducted research highlighting climate change as a significant threat to crop productivity in already food-insecure regions. Through a systematic review and meta-analysis of data from 52 original publications, the study projected an average yield reduction of 8% for eight major crops in Africa and South Asia by the 2050s. Across these regions, wheat, maize, sorghum, and millet were consistently projected to experience negative mean yield changes, ranging from -5% to -17%. However, results for rice, cassava, and sugarcane were inconclusive or contradictory. The study underscores the robust evidence of climate-induced crop yield impacts in Africa and South Asia, emphasizing the urgency of addressing these challenges in food security planning. Kumar et al. (2013) investigated the impact of climate change on wheat production in India, employing the InfoCrop WHEAT model for their analysis. The study predicts a potential reduction in wheat yield ranging from 6 to 23% by 2050 and 15 to 25% by 2080. Projections suggest that areas with late-sown crops will be more adversely affected than those with timely-sown crops. While CO_2 fertilization may offer benefits in the future, regions with mean seasonal maximum and minimum temperatures exceeding 27 and 13°C. The study underscores the significance of simple adaptation measures, such as adjusting sowing times and optimizing input use, to not only counteract yield reduction but also enhance yields until the mid-century. It emphasizes the critical need for intensive, innovative, and location-specific adaptations to bolster wheat productivity in the face of future climate challenges.

DATA AND METHODOLOGY

The purpose of this chapter is to outline the mechanics of studying the problem under investigation. Sections of this chapter deals with the selection of universe of the study, sampling techniques, sample size, data collection methods and

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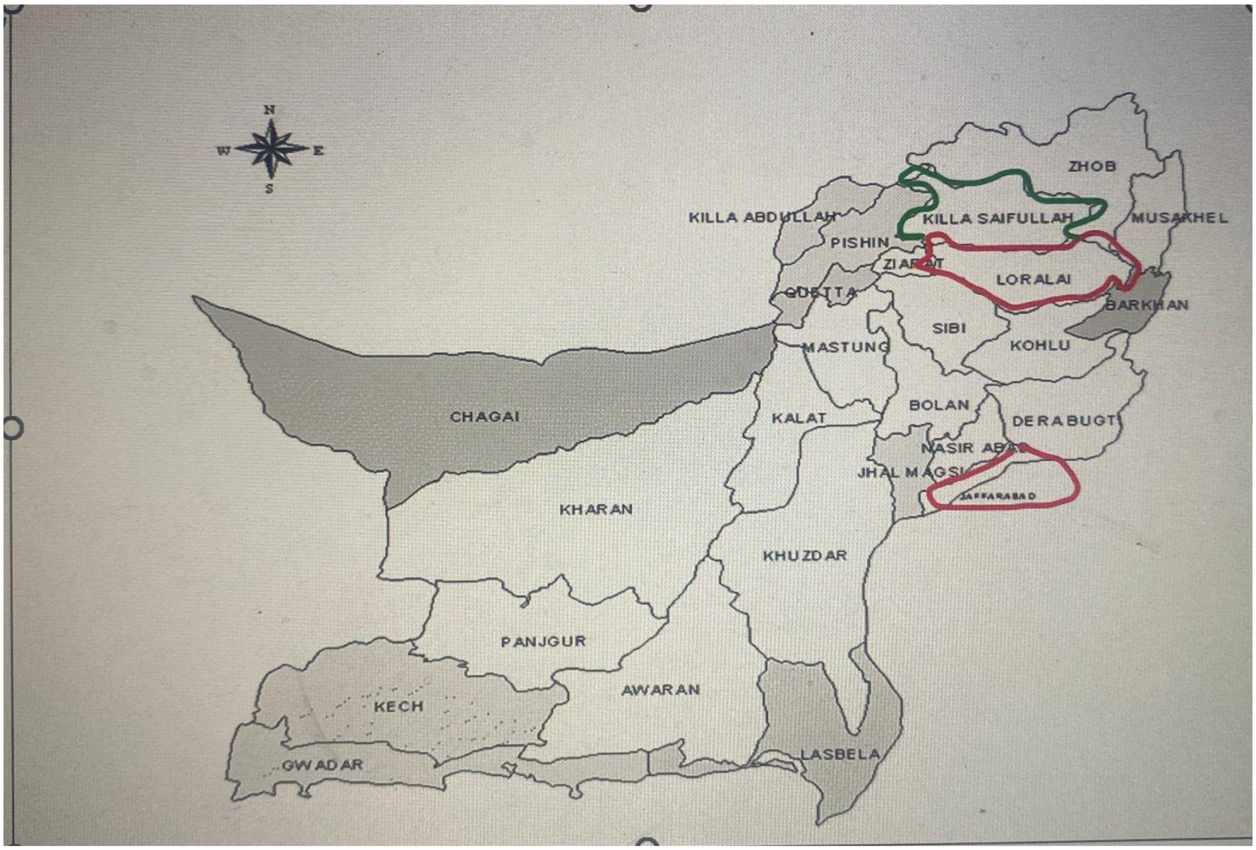
analysis of data. The details of the materials and methods utilized in this study are briefly explained below:

Study Area and Sampling:

This study was conducted in Balochistan Province, located in the South-Western region of Pakistan. Agriculture is the biggest sector and main source of income for the residents. A multistage sampling technique was used form selection of 120 sampled farmers from 3 main agriculture districts- Loralai, Killa Saifullah and Jaffarabad.



Map of Balochistan Province (Google Maps)

Loralai : Is a district located in Pakistan's northeastern Balochistan province. Loralai town serves as the district headquarters.The 1998 census counted 297,600 people, with urban areas accounting for 12% of the total. Pashto is the district's major first language, with 92% of the population speaking it, while Balochi (3.4%) and Punjabi (1.2%) are also spoken.

Killa Saifullah: Is a district in Pakistan's northwestern Balochistan province. It was founded as a district in 1988 by combining two former administrative entities of Zhob District: the Upper Zhob sub-division and the Badinai sub-tehsil, which was previously known as Kashatoo and was part of the Kakar Khurasan subdistrict.

Jaffarabad: Is a district in the southeast of Pakistan's Balochistan province. Jafarabad's headquarters are in Dera Allah Yar, often known as Jhatpat among locals. Jaffarabad District is divided into three Tehsils. The district's primary tribes include Jamali, Umrani, Khoso, Bulledi, Magsi, Babbar, and Behrani, with internally displaced Bugti people also living in Jafarabad. Other minority communities include Gola, Lashari, Domki, and a tiny number of Bhanger and Abro tribes.

Data Collection:
Primary data was sufficient to meet the study's aims, which were obtained using a semi-structured, purpose-designed questionnaire administered via face-to-face interviews. The questionnaire was constructed in such a way that it addresses every facet of the problem.

Data Analysis:
For the analysis of collected data both parametric and non-parametric techniques were used. Descriptive statistical techniques such as mean, mode, percentages, frequency, and standard deviations were calculated to analyze data on households' socio-economics characteristics and their response to different climatic factors and technology adaptation questions for climate change.

RESULTS AND DISCUSSIONS

This chapter report and discuss the results obtained from the analysis of data collected from the sampled respondents in three selected districts of Balochistan province. In the first section demographic characteristics of the farm households are presented. The second section report farmers' perception of climate change its associated hazards. The final section highlights the impact of climate change on the selected major cereal crops.

Socio-economic characteristics:

Farmer's Age: Age is the most important demographic factor. It is the main agent for rejection or adoption of a new idea or technology. The total number of respondents across all districts is 120.
The age group 41-50 has the highest representation, constituting 28.33% of the total respondents.
Where 25% of the respondents in the study area belonged to age group of 51-60 years. The age group 31-40 follows closely, representing 23.33% of the total respondents and the age group above 60 has the lowest representation, accounting for 15.80% of the total respondents.

Table 2: Distribution of Sampled Respondents by Age

Districts	Age group					Total
	21-30	31-40	41-50	51-60	Above 60	
Loralai	2	9	12	10	5	38
Qila Saifullah	3	9	12	10	7	41
Jaffarabad	4	10	10	10	7	41
Total	9	28	34	30	19	120
Percentage	7.5%	23.33%	28.33%	25.00%	15.80%	100%

Source: Author's estimates from the survey data, 2023

Farmer's Education: Education plays a key impact in the adoption of new approaches, as educated individuals are more flexible and appealing to new ideas and technologies compared to the ignorant. Furthermore, an educated individual's perspective or viewpoint is more long-term and realistic than that of an uneducated person. Table 3. Suggested that the total number of sampled farmers across all districts is 120. Farmers with education up to Matric level constitute the highest percentage, accounting for 34.16% of the total respondents. Those with education above Matric level follow closely, representing 35.83% of the total respondents. Farmers with primary-level education make up 15.83%, and illiterate farmers constitute 14.16% of the total respondents.

Table 3 Educational level of the Farmer

Districts	Illiterate	Primary level	Up-to Matric	Above Matric	Total
Loralai	3	4	16	15	38
QilaSaifullah	8	9	12	12	41
Jaffarabad	6	6	13	16	41
TOTAL	17	19	41	43	120
Percentage	14.16%	15.83%	34.16%	35.83%	100%

Source: Author's estimates from the survey data, 2023

Farming experience: Experience is the skill of an individual which comes as the person grow older. Experience play a vital role in selection when someone have many option to choose from.

Table 4 showed that the total number of sampled farmers across all districts is 120. Farmers with 10-20 years of farming experience constitute the highest percentage, accounting for 35% of the total respondents. Those with 20-30 years of farming experience follow, representing 25% of the total respondents and farmers with 0-10 years and above 30 years of farming experience each make up 20% of the total respondents.

Table 4 Farming Experience:

Districts	(0-10) Years	(10-20) Years	(20-30) Years	Above 30 Years	Total
Loralai	7	13	9	9	38
Qilasaifullah	8	12	11	10	41
Jaffarabad	9	17	10	5	41
TOTAL	24	42	30	24	120
Percentage	20%	35%	25%	20%	100%

Source: Author's estimates from the survey data, 2023

Farmers' perception on climate change and induced changes

Table 5 illustrates how sampled farmers responded to changes in climate conditions and associated hazards. The table shows that decreasing rainfall, increasing temperature and frequent drought were well viewed by respondents, as well as how changes in these elements have affected groundwater supply and seasonal fluctuations over the last thirty years. In table 5 showed that 91.3% of farmers perceive an decresed in rainfall intensity, while 2.6% believe it has no change. Only 6% observe have no idea, and 0% observe increased. The majority (82.3%) of farmers perceive an increase in temperature. No farmers report a decrease, 7.2% observe no change, and 10.6% are uncertain. 80.4% of farmers believe there is an increase in the frequency of drought. None report a decrease, 12.8% see no change, and 6.8% have no idea. None of the farmers perceive an increase in the availability of groundwater. However, 94.7% report a decrease, 0% see no change, and 5.3% have no idea. 76.2% of farmers perceive a decrease in the length of the winter period. Only 3.4% observe an increase, 6.4% report no change, and 14% have no idea. The majority (78.5%) of farmers perceive an increase in the length of the summer period. 7.2% report a decrease, 3% see no change, and 11.3% have no idea.

Table 5 Farmers' perception on climate change and associated threats

Variables	Increased	Decreased	No change	No idea
	%	%	%	%
Rainfall Intensity	0	91.3	2.6	6
Temperature	82.3	0	7.2	10.6
Frequency of drought	80.4	0	12.8	6.8
Availability of ground water	0	94.7	0	5.3
Length of winter period	3.4	76.2	6.4	14
Length of summer period	78.5	7.2	3	11.3

Source: Author's estimates from the survey data, 2023

Farmer's perception and its impacts on crops yield

Table 6 shows that how the sampled farmers perceive the impact of variation in climate factors on major crops yield in the study area. Farmers in both irrigated and non-irrigated ecologies perceive a negative impact on wheat yield due to an increase in temperature. For irrigated rice cultivation, the impact of temperature increase is not specified. However, in non-irrigated rice cultivation, farmers perceive a negative impact on yield. In irrigated maize cultivation, farmers perceive a positive impact on yield due to an increase in temperature. In non-irrigated maize cultivation, a negative impact is perceived. Farmers in both irrigated and non-irrigated ecologies perceive a negative impact on wheat yield due to low humidity. For both irrigated and non-irrigated rice cultivation, farmers perceive a negative impact on yield in the presence of low humidity. n both irrigated and non-irrigated maize cultivation, farmers perceive a negative impact on yield due to low humidity. Farmers in both irrigated and non-irrigated ecologies perceive a negative impact on wheat yield due to frequent drought. For both irrigated and non-irrigated rice cultivation, farmers perceive a negative impact on yield in the presence of frequent drought. In both irrigated and non-irrigated maize cultivation, farmers perceive a negative impact on yield due to frequent drought. Farmers in irrigated ecology perceive a negative impact on wheat yield due to low water for irrigation. The perception of non-irrigated wheat yield is not specified. Farmers in irrigated ecology perceive a negative impact on rice yield due to low water for irrigation. The perception of non-irrigated rice yield is not specified. Farmers in irrigated ecology perceive a negative impact on maize yield due to low water for irrigation. The perception of non-irrigated maize yield is not specified. Farmers in both irrigated and non-irrigated ecologies perceive a negative impact on wheat yield due to a reduced winter season. The perception of the impact of a reduced winter season on rice yield is not specified for both irrigated and non-irrigated conditions. Farmers in irrigated and non-irrigated ecologies perceive a positive impact on maize yield due to a reduced winter season. Farmers in both irrigated and non-irrigated ecologies perceive a negative impact on wheat yield due to a prolonged summer season. The perception of the impact of a prolonged summer season on rice yield is not specified for both irrigated and non-irrigated conditions. Farmers in irrigated and non-irrigated ecologies perceive a positive impact on maize yield due to a prolonged summer season.

Table 6 Farmers' perception of impacts of climate change on major crops yield

Climate factors/ induced prob	Wheat Yield		Rice Yield		Maize Yield	
	Irrigated ecology	Non-irrigated	Irrigated ecology	Non-irrigated	Irrigated ecology	Non - irrigated
Temperature increase	-ve	-ve	-	-ve	+ve	-ve
Low humidity	-ve	-ve	-ve	-ve	-ve	-ve
Frequent Drought	-ve	-ve	-ve	-ve	-ve	-ve
Low water for Irrigation	-ve	-	-ve	-	-ve	-
Reduced winter season	-ve	-ve	-	-	+ve	+ve
Prolonged summer season	-ve	-ve	-	-	+ve	+ve

Source: Author's estimates from the survey data, 2023

CONCLUSIONS & RECOMMENDATIONS

It was concluded that due to the increase in temperature and drought the production of wheat and rice decreased in both irrigated and non-irrigated ecology; while in case of maize the production increased in irrigated ecology but decreases in non-irrigated ecology because in case of maize, maize have a potential to resistance temperature, therefore maize production is increased overall in irrigated ecology. Low humidity is perceived by farmers to have a negative impact on the yield of major crops, including wheat, rice, and maize. Similarly, Farmers anticipate that frequent drought conditions will have a detrimental effect on the yield of major crops, including wheat, rice, and maize. Farmers express concerns about the negative impact of low water availability for irrigation on major crop yields, particularly in irrigated ecologies. Farmers anticipate negative impacts on wheat yield in both irrigated and non-irrigated conditions due to a reduced winter season. The perception of a positive impact on maize yield in both irrigated and non-irrigated conditions may suggest that maize is more adaptable to changes in the winter season compared to wheat. As a result is that the farmers are now growing 2-3 crops of maize per season.

Based on the findings the following recommendations are suggested:

- The government should invest in research and development of crop varieties that are more resilient to temperature increases, low humidity, and drought conditions, particularly for wheat and rice.
- Implement and promote efficient water management practices to address concerns related to low water availability for irrigation. This may include the promotion of water-efficient irrigation systems and rainwater harvesting.
- The government developed and implement drought preparedness and response plans that provide support to farmers during periods of frequent drought. This may include early warning systems, financial assistance, and community-based drought management strategies.
- Strengthen and expand early warning systems to provide timely information to farmers about climate variations, including temperature changes, low humidity, and impending drought conditions.
- To Invest in agricultural research to continually assess and understand the changing climate dynamics and develop innovative solutions. Collaborate with research institutions to bridge the gap between scientific knowledge and farmers' needs.
- The government should establish financial support mechanisms and insurance programs to assist farmers in coping with climate-related risks. This could include subsidies for climate-resilient inputs and affordable insurance coverage.
- To strengthen agricultural extension services to educate farmers on climate-resilient practices and strategies. This includes providing information on adaptive measures for different ecological contexts.

These recommendations are based on the perceptions of farmers regarding climate change impacts on major crops. Government interventions should be context-specific, considering the unique challenges faced by farmers in different ecological settings. Additionally, ongoing dialogue with farmers and regular assessments of the effectiveness of implemented policies are crucial for adaptive governance.

ACRONYMS & ABBREVIATIONS

GHG	Greenhouse gases
GDP	Gross Domestic Product
ADB	Asian Development Bank
IPCC	Intergovernmental Panel on Climate Change
KG	Killo gram
Ha	Hectares
SPSS	Statistical Package for the Social Sciences
Co2	Carbon dioxide
NARC	National Agricultural Research Centre
DSSAT	The Decision Support System for Agrotechnology Transfer
°C	Centigrade
Mm	millimeter
GCM	Global Circulation Models

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