International Journal of Contemporary Issues in Social Sciences
Volume 3, Issue 3, 2024 ISSN(P):2959-3808 | 2959-2461

IMPACT OF CLIMATE CHANGE ON WHEAT PRODUCTIVITY: FARMERS PERSPECTIVES

Habib-Ur-Rehman[1], Rahimullah[2], Wakeel U Rehman[3], Shoukat Ali[4], Hassan Sardar[5], Jaffar Hussain[6], Zia Ur Rehman[7], Muhammad Asif[8], Asfand Yar[9] Muhammad Saleem[*10]

[1,4,*10]Institute of Agriculture Extension, Education and Rural Development, University of Agriculture, Faisalabad;
[2,9]Institute of Soil and Environmental Sciences;
[3]Department of Agriculture and Resource Economics, Muhammad Nawaz Shareef-University of Agriculture, Multan;
[5,6,7,8]Department of Agronomy, University of Agriculture, Faisalabad

Corresponding Author: *[*10]saleemshykh@gmail.com

Received: July 20, 2024 **Revised:** August 20, 2024 **Accepted:** September 06, 2024 **Published:** September 16, 2024

ABSTRACT

Wheat has played a vital role in global food security and is a staple food for communities around the world. With the global population expected to rise, the demand for wheat will inevitably increase. However, climate change poses a significant threat to agricultural productivity and food security, and wheat is one of the crops most affected. Given the impact of climate change on declining crop productivity, it is crucial to assess its effect on wheat production. The present study was conducted in the district of Narowal, where 120 respondents were selected to collect data through a well-prepared interview schedule. After data collection, the information was analyzed using statistical software. The results revealed that Akbar-2019, Faisalabad-2008, and Galaxy-2013 were the major wheat varieties cultivated by farmers in the area. A significant majority (84.5%) of the farmers reported an increase in heat intensity over the past five years. Similarly, the majority reported that, due to climate change, the average wheat production in their area had decreased. Additionally, 48.5% of farmers observed premature ripening of the crop. Farmers were asked to categorize their responses regarding the impact of climate change on wheat. Most responses fell under the category of "Medium Extent," with weed growth incidence, pest and disease incidence, reduced soil fertility, lack of water supply, and increased flooding risks reported by 38.5%, 43.4%, 48.4%, and 38.5% of farmers, respectively. There is a need to adopt practices that minimize the impact of climate change. Key practices include cultivating climate-resistant varieties (adopted by 44.4% of farmers), practicing timely cultivation (84.4%), and using insecticides and pesticides (86.9%). In light of the study's findings, steps must be taken to mitigate the effects of climate change. Government and local communities should collaborate, especially in changing agricultural practices and lifestyles. National and international campaigns should be initiated, and policies developed to combat climate change. Additionally, penalties should be imposed on those who violate these policies and regulations.

Keywords: Climate Change, Impact, Productivity, Agriculture, Wheat**,** Adaptation.

INTRODUCTION

Wheat (Triticum aestivum L.) is a vital cereal crop with a significant role in global food security, contributing 20% to daily protein and calorie intake and serving as a staple food for over 35% of the world's population (Rasool et al., 2024). In regions such as North Africa and West Asia, wheat accounts for 40–43% of daily caloric and protein intake. Pakistan, ranking among the top 10 wheat-producing countries, relies heavily on wheat as a dominant crop in terms of both area and production. Wheat contributes 8.2% to agricultural value and 1.9% to Pakistan's GDP, with 80% of the nation's farmers cultivating the crop on 8.95 million hectares, 73.9% of which is located in the

Punjab province (Shewry and Hey, 2015; Govt. of Pak, 2023; USDA, 2024).

However, Pakistan faces growing challenges in ensuring food security due to its rapidly increasing population, projected to double to 400 million in the near future. Wheat production, essential for meeting the food demands of this rising population, is particularly vulnerable to the effects of climate change. Water availability is a critical factor for wheat production, with agriculture consuming 70% of the global freshwater supply. In Pakistan, where water scarcity and inefficient farm-level usage are prevalent, the potential for growth in wheat productivity is significantly hindered by limited water resources (Chauhdary et al., 2024).

Pakistan's geographical location makes it highly vulnerable to climate change, driven by global warming. Situated just north of the Tropic of Cancer and bordering the Arabian Sea, Pakistan's southern half lies along a desert belt that stretches from Rajasthan in India to Thar and Balochistan in Pakistan, and Dasht in Iran. In the north, Pakistan is home to the confluence of three world-renowned mountain ranges: the Himalayas, Karakoram, and Hindukush (Rasul and Ahmad, 2012). Pakistan's climate is highly vulnerable to change, with temperatures expected to rise faster than the global average. Most of the country is arid or semi-arid, receiving limited rainfall. Agriculture is the backbone of Pakistan's economy; climate change poses a serious risk on agriculture. As the shifts in the pattern of monsoon resulted in floods and droughts (Raza et al., 2019).

Climate change in Pakistan has left a lot of effects, especially the increase in temperature. According to an estimate, the temperature in Pakistan will increase from 1.4 to 3.7 °C in 2060, while the temperature in Pakistan has increased to 6 °C by 2090 (Shah et al., 2024). In the same way, there has been an increase in the emission of greenhouse gases. According to an estimate, in 2010, the emission of greenhouse gases at the global level had increased by about six percent and this situation was also in Pakistan. There are various reasons for the increase in temperature on the planet, some of which are as follows, such as the migration of people to cities for work as industries are in the cities, the use of vehicles, the use of refrigerators, the use of fertilizers and pesticides (Carter et al., 2015; Hussain et al., 2019 and Jibran et al., 2015). The effect of climate change is that on the one hand, it causes a decrease in natural resources like due to the flood, a huge amount of water is lost which should be available to our crops. This not only reduces our agricultural productivity but also threatens the availability of water for our future generations (Fahad and Wang, 2020 and Singh et al., 2011).

Agricultural production is impacted by climate change, with rising temperatures significantly reducing the yield of wheat, other crops, and fruits. Unseasonal and sudden rains not only damage crops but also lower their productivity. Similarly, hailstorms contribute to crop destruction. These climate variations particularly disrupt the timing of crop planting and harvesting (Janjua et al., 2010). This means that not only does production decline, but the lack of food for the growing population becomes a serious threat. Therefore, it is essential to take measures to mitigate climate change, as it could lead to global famine and increase the likelihood of conflicts over food resources (Khan et al., 2016).

Global warming and climate change are impacting both the socio-economic and agricultural sectors worldwide. In developing countries like Pakistan, challenges such as glacier melting, flash floods, droughts, rising heat indexes, and insufficient water for crops are becoming more prevalent. Agriculture not only meets the nation’s food needs but also contributes to foreign exchange through exports. As wheat is a key crop, understanding its water demands is crucial, especially as water requirements are expected to increase under warming conditions. This information is vital for future policymaking and planning field activities. The study aims to determine the impact of climate change on wheat. By providing accurate estimates of impact of climate on wheat at different stages, the study will aid in managing irrigation systems and many other practices.

Study area and population of the study

This study area comprises District Narowal, which is divided into three individual administrative units called tehsils: Narowal, Zafarwal, and Shakargarh. To conduct this research, a purposive sampling method was employed to select Narowal district as the study area. This decision was driven by the district's prominence as one of the largest in Punjab, providing a wide range of perspectives and data to analyze. The primary data source for this

research was the office of the Deputy Director of Agriculture (Ext.) Narowal. The list of registered wheat growers was obtained from this authoritative source, offering a comprehensive and reliable dataset for analysis. All registered farmers were the population of study.

Sampling and sample size

In order to ensure a representative sample, random sampling techniques were utilized at two stages. Firstly, twenty villages were selected at random from across the entire district. These villages would serve as the primary research sites for data collection. Secondly, within each selected village, a simple random sampling method was employed to select the respondents 6 respondents from each village. Thus it makes the sample size of 120 farmers.

Data collection tool

A well-structured interview schedule was developed to collect data from the respondents. It includes all the relevant questions which fulfil the need of the study. It was prepared while keeping in view the objectives of the study.

Reliability and Validity

The interview schedule was tested in the field with ten different respondents to check the reliability and after considering the feedback from the trial's participants, the necessary changes were in corporate. No respondents who had previously been subjected to pre-survey screening were included in the final sample size.

The accuracy of the data collection tool is checked by experts by proving the components while keeping in mind the reason. As the accurate facts collection is particularly the outcomes of research instruments having each face and content material validity.The reliability of instrument was ensured by using Statistical software and Cronbach alpha value .96 obtained. This shows the internal reliability and consistency of interview schedule.

Data collection and Data analysis

After ensuring the reliability and validity of instrument. The final data were collected by using this data collection tool. All of the respondents were interviewed face to face. However, questions were asked in both Urdu and Punjabi to ensure that the necessary information were obtained accurately while taking into account the aims of the study. On average, it took between 30 and 40 minutes to get a response from a single respondent; however, in some cases, a lot of time was spent with the farmers just to explain the point of the study. After the collection of data, it was analyzed by using statistical software "Statistical Package for Social Science" (SPSS). Different Statistics values were computed.

Problems the researcher faces when collecting data

The researcher faced an unavoidable challenge during data collection.

1. The vast majority of farmers were illiterate, making it difficult to get useful information from them during the data collection and interviewing phases.
2. Some of them weren't quite ready to offer their opinions on the matter because they were skeptical of the study and its questions. When asked by the researchers about the total land and area under cultivation, production, and income from it, they were unprepared to answer the questions.
3. The study participants were hesitant to take part in the investigation despite the researcher's best efforts to explain the nature of the research and the primary goals it aimed to achieve.
4. They were worried that the researcher worked for the government and would leak the information he or she had gathered.
5. They were worried that the government would impose new and additional taxes on them, making their already difficult situation even more so. Before finally agreeing to do what, we wanted, we had to do a lot of convincing.

Results

The data were analyzed by using statistical tool, the results presented below in this section

Table 1 Distribution of respondents on which type of wheat they grew last year

Verities of wheat	*f*	%
Akbar-2019	30	24.6
Faisalabad-2008	42	34.4
Galaxy-2013	39	32.6
Other	9	8.4
Total	**120**	**100**

In the given table different varieties of wheat those were cultivate by the farmers are given. About one

fourth of the respondents were cultivating Akbar-2019, while about one third (34.4%) were cultivating Faisalabad-2008, about 32% were preferring the cultivation of Galaxy-2013 variety. During the discussion with the farmers, they stated that they were preferring these varieties because these varieties bear high production.

Fluctuation in Temperature

Intensity of heat, a critical component of climate variability, has a significant impact on ecological processes and agricultural ecosystems. It refers to the amount of heat present in the atmosphere and its influence on temperature patterns over a particular time period (Martin et al., 2015). There is diverse effect of temperature on the different crops, in wheat temperature fluctuation effect crop productivity, as reported by Asseng et al. (2011) that temperature variations of ±2°C during the growing season in Australia's primary wheat-growing regions can lead to grain production losses of up to 50%. Keeping in view this, farmers were inquired either they faced the change in heat intensity or not.

Table 2 Distribution of respondents on the basis of heat intensity they felt during the last five years

Statement	Yes *f* (%)	No *f* (%)	Extent	*f*	%
Do you think that heat intensity during last 5 years increased?	107 (84.4)	13 (11.6)	Very low extent	1	0.8
			Low extent	12	10.8
			Medium extent	39	32.6
			High extent	60	49.2
			Very high extent	8	6.6
Total				120	100

According to the data, an overwhelming majority of respondents (84,4%) believe that heat intensity has increased over the past five years. This suggests that awareness campaigns and activities should be conducted at both national and international levels to minimize climate change. Farmers reported during discussions that this year's wheat harvest occurred one and a half weeks earlier than last year, solely due to the effects of climate change.

Increase in heat affected crops

As farmers said that they are aware of climate change. Therefore, it was also necessary to ask them whether their crop production has decreased or increased due to these climatic changes. In the following table, farmers were asked how temperature or other weather changes were reducing their wheat yields.

Table 3: Distribution of respondents on the basis of increase in heat-affected crops

Statement	Yes *f* (%)	No *f* (%)	Extent	*f*	%
Do you think that climate change can cause a decrease in the average yield of wheat?	106 (87.8)	14 (12.2)	Very low extent	4	3.3
			Low extent	9	8.6
			Medium extent	76	62.5
			High extent	27	22.3
			Very high extent	4	3.3
Total				120	100

The data indicate that an overwhelming majority of respondents (87.8%) believe climate change has the potential to reduce average wheat yields. A significant portion (62.5%) of the farmers reported that climate change decreased their wheat production to a moderate extent, while less than a quarter (22.3%) stated that it had a high impact on their production. This data reveals that farmers are highly aware of the impacts of climate change. Therefore, it is crucial for the government, farmers, and the community to take collective action to combat climate change.

Decrease in the yield due to climate

As shown in Table 3, farmers reported that wheat production has decreased due to climate change. Therefore, it was important to ask whether the average wheat production had declined across all areas or only in specific regions. This could help determine if the decrease in wheat yield is widespread or if certain lands are less productive

Table 4 Distribution of respondents on the basis of climate change can cause a decrease in the average yield of wheat

Decrease average yield of wheat	*f*	%
Yes	65	54.3
No	7	5.9
Don't know	48	39.8
Total	120	100

A significant percentage of respondents (54.3%), according to the data, believe that climate is associated with a decline in the average wheat yield. This finding highlights the potential impact of climate variability and change on agricultural productivity, specifically wheat production. The diversity of responses illustrates the complexity of the relationship between climate and wheat yield. As a consequence of climate variability and change, changes in temperature, precipitation, and extreme weather can have both direct and indirect effects on wheat crops.

Pre mature ripping

Premature ripping, which is another name for pre-harvest fruit dropping, is a big problem that affects many different kinds of fruit and causes farmers and orchardists a lot of trouble. The word "premature ripping" means that plants lose fruit before it is fully ripe and ready to be picked. This process, whether it's natural or caused by humans, could cause big problems for agriculture, the economy, and the supply line. The goal of this study is to learn more about premature ripening, including what causes it, how it affects fruit yields, and how it might be stopped.

Table 5: Distribution of respondents on the basis of whether wheat yield has decreased due to premature ripening and to what extent

Statement	Yes *f* (%)	No *f* (%)	Don't know *f* (%)	Extent	*f*	%
Do you think that the yield of wheat has decreased due to premature ripening?	58 (48.5)	5 (4.1)	57 (47.4)	Very low extent	8	6.6
				Low extent	35	29.7
				Medium extent	57	46.7
				High extent	18	15.6
				Very high extent	2	1.4
Total					120	100

A substantial proportion of respondents (48.5%) believe that wheat productivity has decreased due to premature ripening, according to the data. This finding demonstrates an awareness of the detrimental effects of premature maturation on wheat crops and the potential repercussions on agricultural productivity. 46.7% of respondents (57 people) ranked the impact as "Medium extent." The diversity of responses illustrates the complexity of the relationship between premature maturation and wheat yield. Premature ripening, which is frequently caused by factors such as heat stress, disease, and nutrient imbalances, can result in shorter grain-filling periods and reduced grain yields.

Effect of climate change on wheat

Wheat, one of the world most important crops, feeds billions of people. Wheat productivity, the agricultural chain, and the food supply are all threatened by climate change. Rising temperatures and unpredictable weather are threatening wheat cultivation. Climate change threatens wheat output and quality in a variety of ways, including heatwaves and precipitation fluctuations, as well as pests and viruses. To safeguard food supplies and farmers' livelihoods, resilience measures must address the effects of climate change on wheat production. This article examines how climate change affects wheat production and potential solutions.

Table 6 Distribution of respondents on the basis of climate change's effect on wheat production

Statements	Very low extent		Low extent		Medium extent		High extent		Very high extent	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%
Weed growth incidence	19	15.6	39	32.0	47	38.5	14	11.5	1	0.8
Pest/disease incidence	11	9.0	15	12.3	53	43.4	31	25.4	10	8.2
Decrease in yield of crop	2	1.6	21	17.2	39	32.0	46	37.7	12	9.8
Reduce the soil's fertility	11	9.0	21	17.2	53	43.4	29	23.8	6	4.9
Lack of water supply for crops	7	5.7	25	20.5	59	48.4	23	18.9	6	4.9
More Flooding	9	7.4	13	10.7	47	38.5	44	36.1	7	5.7
Pre mature ripening	1	0.8	13	10.7	36	29.5	45	36.9	25	20.5
High rain intensity	5	4.1	21	17.2	48	39.3	34	27.9	12	9.8
Reduced soil moisture	10	8.2	30	24.6	45	36.9	27	22.1	8	6.6

Farmers were inquired about the effect of climate change on the wheat production, framers response was assessed by using the Likert scale. Among the different factors, factors like decrease in yield of crop, more flooding and Pre mature ripening were ranked as “high extent” by 37.7, 36.1 and 36.9% of the respondents respectively. Moreover, few farmers also reported some other effects of temperature on the wheat crop i.e. case of Pest/disease incidence, reduce the soil's fertility, lack of water supply for crops, high rain intensity and reduced soil moisture was also reported by some farmers and they ranked these factor as “high extent”.

Awareness and adaptation practices

Climate change poses a hazard to our planet that is never before seen with far-reaching effects on ecosystems, societies, and economies. Understanding the level of awareness and adoption of climate change adaptation practices is vital for addressing this urgent global crisis. This study aims to examine the current state of climate change awareness among individuals and communities, as well as the wide variety of adaptation practices used to mitigate its effects. This study seeks to shed light on the crucial role of informed decision-making and resilient practices in combating the effects of climate change by analyzing the level of climate awareness and the efficacy of adaptation strategies. By identifying the factors that influence climate awareness and successful adaptation, we can promote sustainable strategies that safeguard our planet's future for future generations.

Table 7 Distribution of respondents on the basis of determining the awareness and adaptation practices that help mitigate the effects of climate change

Statement	No awareness and not done		Have awareness and not done		Have awareness and done	
Cultivation of resistant varieties	*f*	%	*f*	%	*f*	%
	45	36.9	22	18.7	53	44.4
Timely cultivation	3	2.7	14	12.9	103	84.4
Use of chemical substances	5	4.1	9	7.4	106	86.9
Use of green manure organic Fertilizers	12	9.8	31	25.4	77	63.1
Use of farm yard manure	7	5.7	20	16.4	93	76.2
Mulching	60	49.2	37	30.3	23	18.9
Requirement to apply additional water	27	22.1	63	51.6	30	24.6
Premature ripening of crops	5	4.1	18	14.8	97	79.5

Farmers were inquired regarding their awareness and the adoption of the practices adopted by them to mitigate the impact of climate change, it is interesting to know that more than one third (36.6%) of the farmers were not aware about the existence of resistant varieties, therefore they were not adopted these verities. While slightly less than half (44.4%) of the respondents reported they were aware about resistant varieties and adopted them. On the other hand, an overwhelming majority of the farmers were aware about the timely cultivation (84.4%) and use of chemical substances (86.9%) and they were adopting these practices in the actual situation. Only one forth (24.6%) of the respondents reported they were aware about need of additional water requirement to the crop in case of temperature severity. Similarly, the practice of Mulching was not common among the farmers, as it is clear from the table that about 19% of the farmers were aware and adopted the mulching.

Lack of information about climate change

Climate change, which is a worldwide change in temperature trends, weather events, and sea levels, has become the most important environmental issue on the planet. Nonetheless, despite its growing significance, there is a huge gap in public awareness and understanding of climate change and its repercussions. Keeping this in view, farmers were inquired whether they are aware or not about the occurrence of climate change.

Table 8 Distribution of respondents on the basis of lack of information about the occurrence of climate change

Lack of information about the occurrence of climate change	*f*	%
Yes	107	87.8
No	13	12.2
Total	120	100

Table 8 indicates that an overwhelming majority (87.8%) of the respondents reported that they are well aware about the climate

Lack of resources to prevent climate

The urgency of taking effective measures to mitigate the effects of climate change and implementing the proposed solutions has increased. However, the lack of resources to resolve this complex issue is a significant obstacle to success. Governments, organizations, and communities frequently face difficulties in allocating the necessary resources to prevent climate change-related damage due to budgetary and technological constraints. Keeping in view this, the respondents were inquired whether they lacked resources or not to prevent the climate change.

Table 9 Distribution of respondents on the basis of lack of resources to prevent climate change damage and implement recommendations

Lack of resources to prevent climate change damage and implement recommendations	*f*	*%*
Yes	105	86.1
No	15	12.3
Total	120	100

The findings were disturbing, with a high response rate of 86.1% indicating that a considerable majority of respondents recognized a lack of resources to mitigate climate change damage and execute recommended actions. Inadequate resources can stymie successful adaptation and mitigation measures, highlighting a key hurdle in the fight against climate change. Financial constraints are the principal cause of a lack of resources. Climate change adaptation and mitigation can necessitate significant investments in renewable energy technology, infrastructure renovations, and environmental efforts. Limited budgets and funding allocations at the regional, national, and global levels may stymie comprehensive climate change measures.

Discussion

According to table 1, one fourth respondents preferred Akbar-2019 because of its high productivity and many other traits of the variety as reported by Ahmad et al. (2020) that Akbar-2019 is a newly released wheat variety by the Wheat Research Institute at Ayub Agricultural Research Institute, designed for irrigated regions of Punjab, Pakistan. It aims to support food security by gradually replacing susceptible cultivars, helping to prevent yield losses caused by sudden outbreaks of diseases. According to Ahmad et al. (2022) Galaxy-2013 variety was high productive variety as reported by farmers.

In table 2, a vast majority (84.4%) of the respondents reported that there is the increase in temperature from the previous five years. Similar findings reported by Shrestha et al. (2022), according to them vast majority of the farmers have observed shifts in climate conditions. Over two-thirds of the questionnaire respondents and FGD participants reported a perceived increase in the frequency of floods and landslides due to this climatic change. Besides the effects of this climatic change on the humans' life, these changes also effected the productivity of animals as well as of the crops. Janjua et al. (2010) reported that climate change impacts agriculture in various ways, including reduced agricultural output and shortened crop growth periods. Tropical and subtropical regions are likely to experience more severe effects, while temperate regions might benefit to some extent. For instance, wheat plants typically have stalks ranging from 2 to 4 feet in height, with grass-like leaves measuring 8 to 15 inches long. Each stalk ends in a spike, which is 2 to 8 inches long and contains the grain-rich part of the plant. Depending on climate conditions, each spike can hold between 20 to 100 kernels, and in some cases, up to 300 kernels. Wheat does not grow well in consistently warm and moist areas, as excessive precipitation leads to lodging, disease, and challenges in field operations. Farmers mostly change the time of cultivation for the due to the change in climatic condition. Because of this practices the production of crop effected as reported by Khan and Hanif (2007) that delayed planting of wheat beyond mid-December significantly reduces yields, with a 15-20 kg per acre loss for each day of delay after late November. Critical periods for water stress are from adventitious root development to tillering, and from anthesis to milk maturity.

Climate change decrease the production of the wheat as reported in table 3 and 4. This decrease in productivity was just because of the temperature fluctuation as reported by Hussain and Mudasser (2007), Wheat yields for the predominant varieties are expected to decline across all scenarios where climate change leads to temperature increases. This is because the district has already surpassed the optimal temperature range necessary for achieving maximum yields with the current varieties during the growing season. Tahir et al., (2011) found that a temperature increase of 1.5°C could reduce wheat yields by approximately 7%, while a 3.0°C increase could result in a reduction of around 24% compared to the average yield The sowing dates had a significant impact on the germination count per unit area. Germination was highest (190.77 m^{-2}) for seeds sown on December 1, which showed a significant difference compared to those sown on December 15 and December 30. Seeds sown on December 30 had the lowest germination count

(147.44 m^{-2}), significantly lower than those sown on December 1 and December 15. However, the different wheat varieties did not show significant differences in germination counts, and the interaction between sowing dates and varieties was also non-significant Sowing dates had a notable effect on the germination count per unit area. There is the great effect of temperature on the production of grain it is also reported by the farmers as indicated in table 4, that ripening of the crop is affected. Besides the ripening of the seed, temperature also effects in different ways as stated in study of Wollenweber et al. (2003) that wheat is susceptible to heat stress at different phonological stages, but heat stress during the reproductive phase is more detrimental than during the vegetative phase, as it directly impacts grain number and dry weight. Similar effects of climate impacts on wheat crop is also reported in table 6.

There is need to adopt the practices of agriculture which should mitigate the effect of climate change as reported in table 7. Sometime these practices prove effective as reported by Donaldson et al., (2001) increased straw yield from early sowing is due to a higher germination rate, a greater number of tillers per square meter, and taller plant height. But sometimes these practices do not prove effective. As said by Asseng et al. (2011) that early sowing promotes higher straw yields by increasing the number of tillers Temperatures above 34°C cause increased leaf senescence in wheat crops. Singh et al. (2011) reported that as temperatures rise, farmers often adjust their crop cultivation practices, especially the frequency of irrigation. But all farmers do not adopt the innovative practices as many studies reveal that farmers, often with limited literacy, adopt these practices without fully understanding their impact.

Conclusion and Recommendations

The impact of climate change on wheat production in Narowal has become evident, as demonstrated by farmers' observations of increased heat intensity, reduced crop yields, and premature ripening. While efforts to adopt climate-resilient practices, such as using climate-resistant wheat varieties and timely cultivation, are being made, the overall agricultural landscape faces significant challenges.

To address these challenges, it is essential to:

- Promote the use of climate-adaptive wheat varieties on a wider scale.
- Enhance farmer education on climate-resilient farming techniques.
- Encourage collaborative efforts between local communities, government bodies, and international organizations.
- Develop and enforce policies aimed at mitigating the effects of climate change, including penalties for non-compliance.

By adopting these strategies, the resilience of wheat production can be strengthened, ensuring food security for future generations in the face of ongoing climate challenges.

References:

Ahmad, A., Aslam, Z., Javed, T., Hussain, S., Raza, A., Shabbir, R., ... & Tauseef, M. (2022). Screening of wheat (Triticum aestivum L.) genotypes for drought tolerance through agronomic and physiological response. Agronomy, 12(2), 287.

Ahmad, J., Anwar, J., Owais, M., Tanveer, M. H., Javed, A., Nadeem, M., ... & Javaid, M. M. (2020). Akbar-2019: a new high yielding and rust resistant bread wheat variety for irrigated areas of Punjab, Pakistan. Journal of Agricultural Research (03681157), 58(4).

Asseng, S., Foster, I. A. N., & Turner, N. C. (2011). The impact of temperature variability on wheat yields. Global change biology, 17(2), 997-1012.

Carter, J. G., Cavan, G., Connelly, A., Guy, S., Handley, J., & Kazmierczak, A. (2015). Climate change and the city: building capacity for urban adaptation. Prog Plan, 95, 1–66.

Chauhdary, J. N., Li, H., Ragab, R., Rakibuzzaman, M., Khan, A. I., Zhao, J., & Akbar, N. (2024). Climate change impacts on future wheat (Triticum aestivum) yield, growth periods and irrigation requirements: a SALTMED model simulations analysis. Agronomy, 14(7), 1484.

Donaldson, E., Schillinger, W.F. and Dofing, S. M. (2001). Straw production and grain yield relationship in winter wheat. Crop Sci., 2001, 41: 100-106.

Fahad, S., & Wang, J. (2020). Climate change, vulnerability, and its impacts in rural Pakistan: a review. Environmental Science and Pollution Research, 27, 1334-1338.

Government of Pakistan. (2023). Pakistan Economic Survey 2022–23; Finance and Economic Affairs Division, Ministry of Finance, Government of Pakistan: Islamabad, Pakistan,.

Hussain, M., Butt, A.R., Uzma, F., Ahmed, R., Islam, T., & Yousaf, B. (2019). A comprehensive review

of sectorial contribution towards greenhouse gas emissions and progress in carbon capture and storage in Pakistan 20, 1–20.

Hussain, S. S., & Mudasser, M. (2007). Prospects for wheat production under changing climate in mountain areas of Pakistan–An econometric analysis. Agricultural systems, 94(2), 494-501.

Ishaque, W.; Osman, R.; Hafiza, B.S.; Malghani, S.; Zhao, B.; Xu, M.; Ata-Ul-Karim, S.T. (2023) Quantifying the impacts of climate change on wheat phenology, yield, and evapotranspiration under irrigated and rainfed conditions. Agric. Water Manag. , 275, 108017.

Janjua, P. Z., Samad, G., Khan, N. U., & Nasir, M. (2010). Impact of climate change on wheat production: A case study of Pakistan [with comments]. The Pakistan Development Review, 799-822.

Janjua, P. Z., Samad, G., Khan, N. U., & Nasir, M. (2010). Impact of climate change on wheat production: A case study of Pakistan [with comments]. The Pakistan Development Review, 799-822.

Jibran, M., Zuberi, S., & Shazia, F. A. (2015). Greenhouse effect reduction by recovering energy from waste landfills in Pakistan. Renew Sust Energ Rev, 44, 117–131

Khan, A., Mohammad, K., Ali, J., Ali, Z., Ahmad, I., & Ahmad, N. M. (2016). The challenge of climate change and policy response in Pakistan. Environ Earth Sci, 75, 1–16.

Khan, M. A., Khan, J. A., Ali, Z., Ahmad, I., & Ahmad, M. N. (2016). The challenge of climate change and policy response in Pakistan. Environmental Earth Sciences, 75, 1-16.

Martínez-Ballesta , M. C. , López-Pérez , L. , Muries , B. , Muñoz-Azcarate , O. and Carvajal , M. 2009 . " Climate change and plant water balance: the role of aquaporins – a review " . In Climate Change, Intercropping, Pest Control and Beneficial Microorganisms , Edited by: Lichtfouse , E. 71 – 89 .

Martin-Vide, J., Sarricolea, P., & Moreno-García, M. C. (2015). On the definition of urban heat island intensity: the "rural" reference. Frontiers in Earth Science, 3, 24.

Rasool, G., Anjum, M. N., Azam, M., Hussain, F., Afzal, A., Maeng, S. J., & Min, K. C. (2024). Projecting Climate Change Impact on Precipitation Patterns during Different Growth Stages of Rainfed Wheat Crop in the Pothwar Plateau, Pakistan. Climate, 12(8), 110.

Rasul, G., & Ahmad, B. (2012). Climate change in Pakistan. Pakistan Meteorological Department.

Raza, M. H., Bakhsh, A., & Kamran, M. (2019). Managing climate change for wheat production: An evidence from southern Punjab, Pakistan. Journal of Economic Impact, 1(2), 48-58.

Roco, L., Engler, A., Bravo-Ureta, B. E., & Jara-Rojas, R. (2015). Farmers' perception of climate change in mediterranean Chile. Regional environmental change, 15, 867-879.

Shah, S. A. A., Wu, H., Farid, M. F., Tareen, W. U. H., & Badar, I. H. (2024). Climate Trends and Wheat Yield in Punjab, Pakistan: Assessing the Change and Impact. Sustainability, 16(11), 4443.

Shahzad, K., Bakht, J., Shah, W.A., Shafi, M. and Jabeen, N. (2002). Yield and yield components of various wheat cultivars as affected by different sowing dates. Asian J. PI. Sci.,, 1(5): 522-525.

Shewry, P.R.; Hey, S.J. (2015). The contribution of wheat to human diet and health. Food Energy Secur. , 4, 178–202

Shrestha, R., Rakhal, B., Adhikari, T. R., Ghimire, G. R., Talchabhadel, R., Tamang, D., ... & Sharma, S. (2022). Farmers' perception of climate change and its impacts on agriculture. Hydrology, 9(12), 212.

Singh, A., Singh, D., Kang, J. S., & Aggarwal, N. (2011). Management practices to mitigate the impact of high temperature on wheat: a review. IIOAB J, 2(7), 11-22.

Tahir, M., Ali, A., Nadeem, M. A., Hussain, A., & Khalid, F. (2009). Effect of different sowing dates on growth and yield of wheat (Triticum aestivum L.) varieties in district Jhang, Pakistan. Pak. J. Life Soc. Sci, 7(1), 66-69.

Tahir, M., Ali, A., Nadeem, M. A., Hussain, A., & Khalid, F. (2009). Effect of different sowing dates on growth and yield of wheat (Triticum aestivum L.) varieties in district Jhang, Pakistan. Pak. J. Life Soc. Sci, 7(1), 66-69.

USDA. (2024). Pakistan: Grain and Feed Annual, Global Agricultural Information Network (GAIN). 2017. Available online: https://fas.usda.gov/data/pakistan-grain-and-feed-annual-1 (accessed on 8 April 2024).

Wollenweber , B. , Porter , J. R. and Schellberg , J. 2003 . Lack of interaction between extreme high-temperature events at vegetative and reproductive growth stages in wheat . J. Agron. Crop Sci. , 189 : 142 – 150 .