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Farmers' Perception Regarding Natural Hazards and Impact on Food Productivity: Evidence from Rice-Wheat Cropping Zone of Punjab, Pakistan

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Globally, climatic vulnerabilities and natural hazards adversely affect crop productivity and food security. The yield of major crops in Pakistan is badly affected by natural adversaries, which is a source of poverty. It is predicted that the near future food insecurity issue can prevail in Pakistan due to these hazards. Due to climatic and natural hazards, a decline in agricultural productivity affects the farming community, manufacturing, and business sectors through a multiplier effect. The study was designed during 2020 to assess the farmers' perceptions regarding the impact of natural hazards on food crop production in the Rice-Wheat cropping zone of Punjab, Pakistan. Data were collected from 540 farmers using Multistage Random Sampling Technique (MRST). The study ranked natural hazards based on the mean score of the Likert Scale of farmers' perceptions. Food productivity was adversely prone to flood, insect infestation, biological diseases, extreme heat, wind storms in summer, hailstorms, and heatwaves. However, there was a positive impact of humidity on food production. So, appropriate policies should be formulated to mitigate the antagonistic impact of natural hazards on rice-wheat production, ensuring food security via increasing food production (availability) and income (accessibility).
Keywords: Perceptions, natural hazards, impact, food productivity, availability, accessibility.

INTRODUCTION

Globally incidence and intensity of extreme weather and climatic events have augmented due to climate change (IPCC, 2018). Agriculture sector provides food to over seven billion people and livelihood to more than half of the world population (Abdullah *et al.,* 2005; Khan *et al.,* 2020). The agriculture is an economic activity that produces food as well as livelihood for human beings. Still, it is highly dependent and vulnerable to climatic and natural hazards like drought, flood, increasing of global and regional temperature, uneven rains, insect infestation, and biological diseases, etc. Food security at the global and regional levels is under severe threat in future climatic projections (Field *et al.,* 2014; Ndamani and Watanabe, 2017).

Variation in precipitation and increased surface temperature due to climatic hazards pose serious consequences to developing countries like Pakistan (Ali and Erenstein, 2017; IPCC, 2018). Due to scarce resources, less adaptation, and dry topographical background, Pakistan is highly vulnerable to natural calamities (Schilling *et al.,* 2013). In last two decades, Pakistan has faced a rise in frequency, degree, and harshness of natural and climatic hazards, including floods, droughts, water shortage, extreme temperature, hailstorms, uneven rains, and high existence of pests and diseases (Smit and Skinner, 2002; Ali and Erenstein, 2017). In weather and climatic risks of 2009–2010, 2010–11, 2012 and 2015, Pakistan was graded as the 29th, 16th, 12th, and 8th, respectively, among greatest vulnerable countries (Khan and Fee, 2014; Abid *et al.,* 2016), and ranked 7th among the highest prone areas of the biosphere (Kreft *et al.,* 2013). In Pakistan, consecutive floods of 2010, 2011, 2012 and 2014 and severe droughts from 1999 to 2003 are common examples of climatic and natural hazards (Abid *et al.,* 2017). Risk awareness, attitude, and adaptation measures are vital factors affecting farm investment, management decisions and productivity. Farmers seem that severe climatic and weather changes can pose a gigantic risk to the agricultural sector in the forthcoming period (Khan *et al.,* 2020), so their livelihood and food security.

The agriculture sector in Pakistan is under extreme threat to climatic and natural hazards related risks. Major cereal and food crops face a significant decline in yield due to climatic events, which poses a severe threat to food security. In the past few years, rice a staple food in Pakistan is extremely susceptible to life-threatening climatic risks (Ahmad *et al.,* 2015; Ali and Erenstein, 2017; Abid *et al.,* 2018). The production of rice in Pakistan from the last few years has

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reduced by 20 percent due to fluctuating patterns of monsoon rains and depleting water resources (Ahmad *et al.,* 2015). Furthermore, the Rice-Wheat zone, along with eleven districts of Punjab, are severely affected by the recent successive floods (PDMA, 2014). In addition, rice yield could reduce by 25 percent from 2040-2069 and 36 percent from 2070-2099 if the temperature continues to escalate in Pakistan (Ahmad *et al.,* 2015). Likewise, rice production would decline by 6 percent with decreasing average precipitation, and it will increase 29 percent net irrigation water requirement (Ali and Erenstein, 2017).

The farming communities' food and livelihood sources in Pakistan largely depend on agriculture, so it is essential to provide knowledge about climatic and natural hazards to concerned stakeholders. Understanding climatic hazards and their impacts on agricultural production system is fundamental in smart decisions-making process and hence developing effective management strategies to cope with these calamities and hazard (Farani *et al.,* 2019). Strategies to manage risk like adaptation and extenuation help the growers to minimize or avoid the possible losses to their crops (Frank *et al.,* 2010; Moghariya and Smardon, 2014). Farmers' livelihood, directly or indirectly linked with climatic and natural hazards, affects their intention to the perceived risks. Risk attitude is responds to uncertain conditions (Gattig and Hendrickx, 2007).

Risk perception and risk attitude are usually used in decision-making and policy planning regarding climatic vulnerabilities. Under risk conditions, the attitude of the farmers determines their choice to realize the risk on the production of crops. Likewise, perception of risk influences their aims to retort the professed costs, which eventually leads to actual managing of risk (Sjoberg *et al.,* 2004). Thus, farmers' perception of risks plays an essential role in making timely and accurate decisions in farm and management and accelerating their adaptive capacity against climatic and natural hazards. Thus, current study was planned to examine farmers' perceptions about climatic and natural hazards and their impacts on production of Rice-Wheat in the rice-wheat cropping zone of Punjab, Pakistan.

MATERIALS AND METHODS

***The study area*:** The Rice-Wheat Cropping System (RWCS) is one of the largest cropping systems in the world (Han *et al.,* 2020). In Asia, RWCS has an extensive history. Since 700 AD in China, this system has been practiced and in Pakistani Punjab since 1920 (Gupta et el., 2004; Chauhan *et al.,* 2012). RWCS in Southeastern Asia has 24 million hectares. There is nearly15.5 million hectares area in South Asian countries, of which India, Pakistan, Bangladesh, and Nepal have 10, 4.25, 0.8, and 0.5 million hectares, respectively (Chauhan *et al.,* 2012; Nath *et al.,* 2019). In Pakistan, the source of livelihood of around 1.1 million farm families is supported by RWCS (Khaliq *et al.,* 2019). The total area under cultivation is 22.54 million ha, out of which 4.25 million ha is under RWCS, accounting about 19% (FAO, 2004). Punjab has a 2.8 million ha area under RWCS, which covers nearly 66% of RWCS and 12% of the total agricultural area of Pakistan. In a nutshell, the total cultivated area of Pakistan is 56.2 percent in Punjab, similarly, 53 percent of the total agricultural gross domestic product (Pakistan Bureau of Statistics, 2020). Agriculture is

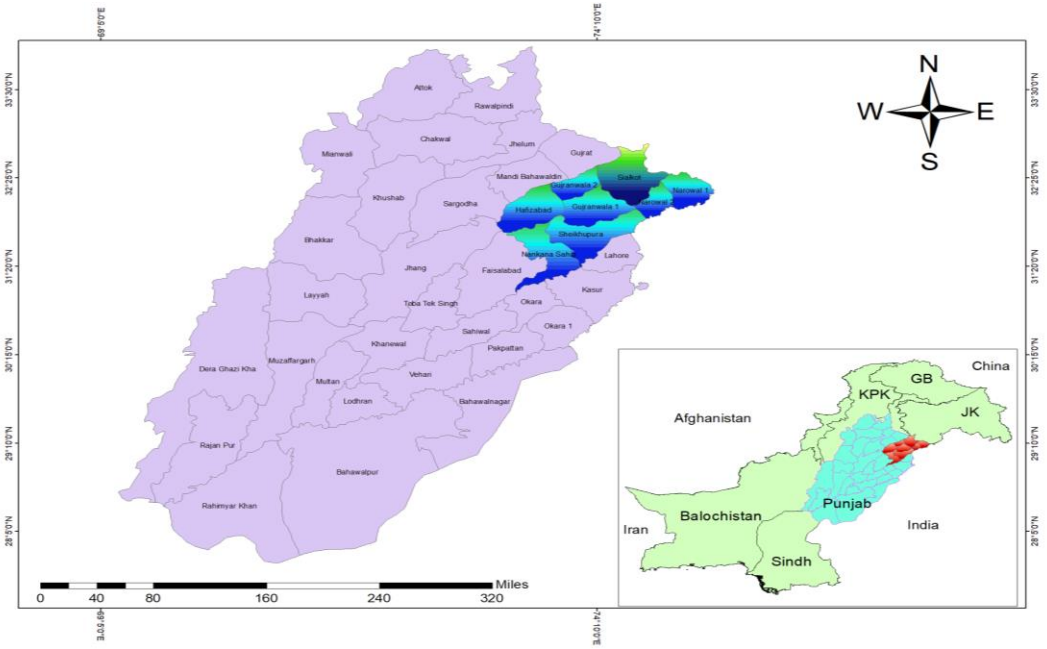

Figure 1. Map of the Selected Rice Districts on the Map of Punjab, Pakistan.

the biggest employer in the province, especially in rural areas where it employs 60% of the workforce (GOP, 2020). RWCS in Punjab, Pakistan is mainly prevailing in district Sheikhupura, Gujranwala, Sialkot, Hafizabad, Nankana Sahib, and Narowal (Crop Reporting Services, 2020). Purposely Rice-Wheat zone was chosen for the study because of its importance in ensuring food security.

***Sampling and data collection*:** Multistage Random Sampling Technique (MRST) was used for data collection. At stage one, the RWCS of Punjab was selected. During the stage, the top six main rice-producing districts, i.e., Gujranwala, Sialkot, Narowal, Sheikhupura, Hafizabad, Nankana Sahib, based on area under rice and production were selected. In stage third, the major canal distributary irrigating to the selected districts was selected. One village from the head, middle, and tail of the selected canal distributary was selected at stage four. Finally, 30 farmers were interviewed from each village randomly; thus, the total sample size was 540 respondents.

Analytical framework

***Perception of natural hazards*:** Awareness regarding risks of climatic and natural hazards and their impact on food production was proved to the rural farm household respondents. Questions regarding extreme events related to climatic, environmental, and natural hazards were inquired by responding categorically in the form of Likert Scale (one being the strongly disagree and five strongly agree) during the last two decades (2000–2020). Natural hazards like floods, hailstorms, biological diseases, insect infestation, wind storms in summer, wind storms in winter, extreme heat, heat waves, early rains, late rains, extreme cold, drought, typhon, smog, fog, heavy rains, frost, and humidity were prepared to examine the farmers' perception about risks, and perceived impact of these natural hazards on food production. Perceptions of the farmers about climatic hazards were assessed by applying descriptive statistics. Frequencies of the answers were summarized as percentages to establish graphs.

***Empirical Model*:** To examine the impact of climatic and natural hazards on the food crop productivity, Binary Logistic Regression Model was used. Assuming that a random variable Y represents food crops productivity due to climatic and natural hazards and X is a vector of eighteen hazards. The results of such dichotomous could be estimated by using an inferential statistical Logit model (Fosu-Mensah *et al.*, 2012). P (y = j/x) may be assessed by using a Binary Logit model (Acquah, 2011; Khan *et al.*, 2020) and computing the outcome of vector X on the response likelihoods.

$$P(Y_i = j/X_i) = F(Z_j) = \frac{e^{Z_j}}{1+e^{Z_j}} = \frac{1}{1+e^{-z}} \quad (1)$$

$$Z_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} \ldots\ldots \beta_n x_{ni} + \mu_i \quad (2)$$

The Binary Logit model described by Mabe *et al.* (2014); Khan et al. (2020) as:

$$ln\left[\frac{P_j}{1-P_j}\right] = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} \ldots \beta_n x_{ni} + \mu_i \quad (3)$$

where n = 1,2, 3,…..18.

A five-point Liker scale (1 = Strongly Disagree; 2 = Disagree; 3= Undecide; 4= Agree; 5= Strongly Agree) was used to examine the effect of possible eighteen natural hazards on the food crop productivity constructed on their experience and perception.

$$\text{Mean} = \frac{1+2+3+4+5}{5} = 3$$

Decision rule: A value ≥ mean, infers significant affect of natural hazards on the food crop productivity, otherwise, no serious affect is specified.

RESULTS

Average age of the respondents plays key role in growing of crops and rearing of animals. Average age of the respondents was 41 years with a minimum of 20 and maximum 65. Unfortunately, in developing countries including Pakistan educated people are not being engaged in agriculture sector. Education contribute significantly while taking several decisions in production of crops and management of livestock animals. Mean years of schooling of sampled farmers was 8 years with a maximum of 18 years and minimum of illiterate. Sampled famers have vast experience of livestock farming as well as of growing crops. The average farming experience in the study area was 20 years with a maximum of 25 years and minimum 01 years. The average family size of the respondents was five with a minimum of four and maximum of ten. Agriculture is a labor extensive enterprise. There is a need of huge amount of labor for all agricultural activities particularly during peak seasons i.e., sowing and harvesting. In Pakistan majority of the farmers are small having land holing less than 12.5 acres. The mean operational land acreage was 9 with a minimum of 01 and maximum 39.

Table 1. Socioeconomic Characteristics of Respondents

Variable	Mean	Min	Max	Std. Dev.
Age (years)	41	20	65	9.79
Education (years)	8	0	18	5.10
Farming experience (years)	20	1	25	10.99
Household size (No.)	5	4	10	1.44
Operational land holding (acres)	9	1	39	5.47
Monthly income (PKR)	43676	21000	148000	22673.60

Source: authors' own survey results, 2020

Table 2. Farmers' Perceptions Regarding Climatic and Natural Hazards

Climatic and Natural Hazards	Strongly disagree 1 (%)	Disagree 2 (%)	Undecide 3 (%)	Agree 4 (%)	Strongly agree 5 (%)
Floods	5.6	9.6	12.8	17.4	54.6
Drought	6.7	6.9	18.7	25.7	42.0
Too much rains	8.0	7.2	8.1	28.9	47.8
Early rains	1.1	10.9	12.4	16.1	59.4
Late rains	1.3	9.4	15.2	15.2	58.9
Extreme cold	4.6	3.9	20.6	23.3	47.6
Extreme heat	3.0	7.4	18.9	18.0	52.8
Wind storm in winter	1.1	5.6	15.2	19.1	59.1
Wind storm in summer	3.5	7.4	16.9	16.3	55.9
Fog	6.9	6.7	15.6	18.5	52.4
Smog	5.4	4.6	16.1	19.6	54.3
Frost	6.3	4.1	19.6	25.0	45.0
Hailstorms	4.6	4.3	18.7	18.5	53.9
Heat waves	7.6	8.5	11.5	20.4	52.0
Humidity	4.6	10.2	22.0	19.8	43.3
Typhon	7.0	9.1	13.3	13.1	57.4
Insect infestations	1.9	2.8	29.1	23.0	43.3
Biological diseases	3.3	8.7	16.3	13.9	57.8

Source: authors' own survey results, 2020.

Table 3. Ranking of Perceptions Regarding Natural Hazards by the Respondents

Natural Hazards	Minimum	Maximum	Mean	Std. deviation	Ranks
Floods	1	5	4.2944	0.98992	1
Hailstorms	1	5	4.2185	1.10002	2
Biological diseases	1	5	4.2093	1.09252	3
Insect infestations	1	5	4.1407	1.17116	4
Wind storm in summer	1	5	4.1370	1.15083	5
Extreme heat	1	5	4.1278	1.16551	6
Heat waves	1	5	4.1278	1.13975	7
Early rains	1	5	4.1019	1.12766	8
Late rains	1	5	4.0593	1.24845	9
Extreme cold	1	5	4.0537	1.11944	10
Wind storm in winter	1	5	4.0481	1.30558	11
Droughts	1	5	4.0315	1.00136	12
Typhon	1	5	4.0296	1.25099	13
Smog	1	5	4.0130	1.25202	14
Fog	1	5	4.0074	1.28930	15
Too much rains	1	5	3.9833	1.17397	16
Frost	1	5	3.8963	1.21386	17
Humidity	1	5	3.8704	1.20983	18

Source: authors' own survey results, 2020

Average monthly income of the farmers from farm and off-farms earning was estimated to be PKR 43676. It was observed that farmers that has only farm income were less stable as compared to those farmers who has both farm as well as off-farms sources of income (Table 1).

The frequency of farmer's perceptions regarding their impact on food productivity is presented in Table 2 and Figure 2. The majority of the farmers were found to be agreed and strongly agree regarding the impact of the climatic and natural hazards on food productivity. Farmers' perception about the impact of climactic and natural vulnerabilities on the food production in the Rice-Wheat cropping system indicated that farmers are well aware of the possible impacts of these events on crops, income, and ultimately food security. The study also ranked the impact of climatic and natural hazards (Table 3). There was the highest impact of the flood on food crops production followed by hailstorms, biological diseases, insect infestations, wind storms in summer, extreme heat,

heatwaves, early rains, late rains, extreme cold, wind storms in winter, droughts, typhon, smog, fog, too much rains, frost, and humidity.

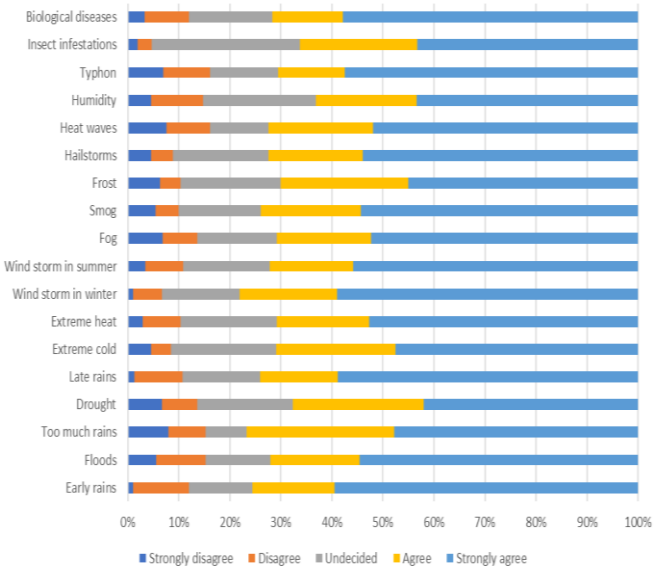

Figure 2. Farmers' Perceptions Regarding Natural Hazards (Source: author's own survey results, 2020)

So, appropriate polices and guidelines should be prepared for the general public and particularly for the farming community to manage the adverse impact of natural hazards on crops, hence ensuring rural livelihood and food security.

A Binary Logistic Regression model was employed to identify the impact of natural hazards on food productivity. There was a positive but insignificant impact of drought on the productivity of Rice-Wheat Cropping System (RWCS). The variable of the flood was negatively and significantly affecting the food production. Pakistan has faced severe floods during the last two decades. These floods had affected a large area under food crops. Heavy rains are beneficial for rice crop; however, it affects the wheat crop adversely. The effect of heavy rains was found to be positive and insignificant. Uneven rains have negative effects on the production of food crops. Early and late rains have negative and significant effects (Table 5). In Pakistan food crops, particularly wheat, has been badly affected at the harvesting stage due to rain. Furthermore, extreme hot and extreme cold variables have negative and insignificant impacts on the dependent variable. They significantly decline food production. Extreme cold, wind storm in winter, fog, smog, and typhon have a negative but insignificant impact on the outcome variables.

Table 4. Farmer's Perception Regarding Impact of Natural Hazards on Crop Production

Response	Frequency	Percentage
No impact on Crop Production (=0)	292	54.1
Have impact on Crop Production (=1)	248	45.9
Total	540	100.0

Source: authors' own survey results, 2020.

Table 5. Results of Binary Logistic Regression

Natural Hazards	B	S.E.	Wald	Df	Sig.	Exp(B)
Drought	0.137	0.096	2.023	1	0.155	1.146
Flood	-0.173	0.061	8.005	1	0.005	0.842
Too much rains	0.063	0.083	0.569	1	0.451	1.065
Early rains	-0.147	0.092	2.564	1	0.109	0.864
Late rains	-0.081	0.092	0.781	1	0.377	0.922
Extreme heat	-0.174	0.087	4.037	1	0.045	0.840
Extreme cold	-0.114	0.095	1.443	1	0.230	0.893
Wind storm in winter	0.049	0.063	0.593	1	0.441	1.050
Wind storm in summer	-0.155	0.089	3.054	1	0.081	0.857
Fog	0.072	0.088	0.667	1	0.414	1.074
Smog	-0.039	0.090	0.189	1	0.664	0.962
Frost	0.150	0.093	2.599	1	0.107	1.162
Hailstorms	-0.430	0.095	20.420	1	0.000	0.650
Heatwaves	-0.262	0.093	7.994	1	0.005	0.769
Humidity	0.184	0.092	3.978	1	0.046	1.202
Typhon	-0.049	0.093	0.279	1	0.598	0.952
Insect infestations	-0.606	0.129	21.955	1	0.000	0.546
Biological diseases	-0.143	0.067	4.568	1	0.033	0.867
Constant	6.608	1.304	25.672	1	0.000	740.958

Source: authors' own survey results, 2020

Table 6. Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
653.110	0.156	0.209

Source: authors' own survey results, 2020

Extreme heat was affecting crop production negatively. It causes more evaporation, and thus, plants require more irrigation which accelerates the production cost. Similarly, heat waves and wind storm in winter has a significant and negative impact on the productivity of food crops. It has been experienced that hailstorms ruined the food crops brutally in Pakistan. Wheat and rice production are declined with hailstorms, particularly when these crops are at ripening and harvesting stages. The attack of insects and recently locust breakdown has brutally affected the Pakistan's agriculture and food security. Insect infestation was found to affect crop production negatively and significantly. In Pakistan agriculture sector is the main victim of biological diseases and a huge amount of food production is prone to these diseases. The Binary Logistic Regression model explained that biological diseases have a negative and significant impact on food production in RWCS. The value of -2 Log likelihood (653.110), Cox & Snell R Square (0.156), and Nagelkerke R Square (0.209) purported the overall significance of the model (Table 6).

DISCUSSION

The Rice-Wheat cropping zone of Punjab, Pakistan, is vulnerable to unpredictable risks related to climate and weather. Consequently, preventive measures should be designed to avoid the possible risks to food production, rural livelihood, and food security. Many studies (Bryan *et al.,* 2013; Harvey *et al.,* 2014; Abid *et al.,* 2016; Tran *et al.,* 2017; Akhtar *et al.,* 2019; Amir *et al.,* 2020) has elaborated the possible threat of climate change to the agriculture sector. Socio-ecological landscape of Pakistan is under serious threat of climatic hazards (Ali and Erenstein, 2017; Abid *et al.,* 2018). Goals of accomplishing food security and poverty reduction are jeopardized with the current weather and climatic abnormalities (Ali and Erenstein, 2017). The current study evaluated rural farming communities' perception of climatic and natural hazards and their impact on food crops production in Punjab, Pakistan.

The study explored that uneven rains in the study area declined production of Rice-Wheat in RWCS. This result is in line with the study of Khan et al. (2020), who reported that when the rice cultivation starts in the RWCS, the monsoon season mostly starts late. At this time there is a need for irrigation water and farmers rely on this seasonal rain. So, wheat and rice production may fall due to uneven and short rainfall; as a result, availability as well as rural farm income and food security decreases. Time series data of rain fall and temperature reported by the Pakistan metrological department also revealed a decline of rainfall and an increase in temperature in the research site. Crop health and yield have significantly deteriorated with biological risks like weed germination, pest and insect attacks, and crop diseases. In Pakistan, the crop sector, mainly cereal production, is victim to many biological risks (Usman *et al.,* 2012; Khaliq *et al.,* 2014; Khan *et al.,* 2020).

In Pakistan, every four out of 10 years, a drought was observed, which had a catastrophic effect on all sectors and, so, on people's livelihoods and food security (Durrani *et al.,* 2021). For the last two decades, drought has been prevalent and farmers have perceived it consistently. Economic dependence on crops and livestock, shrinking surface water resources, reduction of groundwater and inadequate supply of electricity have further augmented their vulnerability to drought. Socioeconomic impacts of drought are loss of employment and reduced the production of crops and livestock. An increase in social crimes, drop out of schoolchildren, migration to other places, impacts on health and festivals are social impacts of the drought. Decrease in intensity of rainfall, rising temperature, and non-climatic factors are environmental impacts due to the prevalence of drought. Farmers' understanding of risk perception about drought may help develop policy making to design suitable intervention strategies for its mitigation (Durrani *et al.,* 2021). Food security at household, national and global levels is negatively affected by droughts, floods, temperature, frequent fluctuation of rainfall patterns due to increased intensity of environmental hazards (Alam *et al.,* 2018; Privara and Privarova, 2019). Flood hazards increased food prices due to disequilibrium of demand and supply of food, and abridged crop production is negatively affecting low-income and poor households' food access. Food prices are further rising due to regional as well as global population expansion (Abbas *et al.,* 2017; Ahmad *et al.,* 2019). As global warming patterns of rainfall and temperature are changing, so, disturbing crop production (Abbas and Mayo, 2021). Pakistan has been facing extreme floods for the last two decades due to natural and climatic vulnerabilities which are declining productivity of food crops and deteriorating rural livelihood (Ahmad *et al.,* 2020).

There are many studies that assessed the impact of rainfall and temperature on crop yield by applying input-output production function (Brown and Rosenberg, 1997; Echevarria, 1997; Porter and Stern, 2000; Xepapadeas *et al.,* 2007; Wu *et al.,* 2008; Meisheng, 2009; Yuan, 2011; Mahmood *et al.,* 2012; Zhang *et al.,* 2015; Abbas *et al.,* 2016). The study of Nicholls (1997); Lobell and Asner (2003) used Cobb–Douglas type production function to examine the

impact of climate change due to global warming on Rice-Wheat yield in Australia. Rice yield was reduced due to intensification in minimum temperature (Peng *et al.*, 2004).

Globally, patterns of rainfall and temperature are affected by vulnerabilities of climate change and have a substantial effect on the yield of crops. Efficient and effective use of agricultural resources to gain the best and highest output is called productivity (Hejazi *et al.*, 2012). Farmers are facing frustration, social and economic losses due to unfavorable environmental alterations. The productivity of food and cash crops in Pakistan is badly affected by the severe climatic changes that have posed a serious threat to livelihood and food and raw material security (Ahmad and Afzal, 2020a). Moreover, Pakistan's agricultural productivity and rural livelihood in Pakistan have been adversely influenced due to regional and global climatic dynamics during the last twenty years. Farm losses at the farm level can be abridged by implementing timely and effective climate change adaptation measures (Ahmad and Afzal, 2020b).

Global warming is altering the pattern of temperature and rainfall, which significantly influences the growing phases of crops (Sridevi and Chellamuthu, 2015). Parry et al. (2013) stated that discrepancy in rainfall and temperature has a negative effect on rice development stages subsequently, production of rice declined. Quantity of plants and degree of tillering in rice are badly affected by high maximum and minimum temperatures, decreasing the yield at the stages of tillering and elongation of stem (Mahbubal Alam *et al.*, 1985). Furthermore, rice production decreases due to maximum temperature at the propagative stage resulting abridged crop duration (Dabi and Khanna, 2018). In Punjab Mahmood et al. (2012) stated that rice productivity is negatively affected by the increase in rainfall pattern during the propagative and maturing stages.

***Conclusion and recommendations*:** The current study was conducted in the Rice-Wheat Cropping Zone of Punjab province of Pakistan, which contributes to over half of the country's rice production. In Punjab, rice and wheat yield has significantly decreased due to many climatic and natural hazards, so a significant pressure on the livelihood and household and national food security. Thus, keeping in view the reduced Rice-Wheat yield in the region due to vulnerability of climatic and natural hazards, this study examined the perception of RWCS growers towards climatic and natural hazards and their impacts on rice and wheat production. The majority of the farmers were found to be agreed and strongly agree regarding the impact of the climatic and natural hazards on food productivity. According to results estimated by binary logistic regression, food productivity of the region was adversely prone to flood, insect infestation, biological diseases, extreme heat, wind storms in summer, hailstorms, and heatwaves. However, there was a positive impact of humidity on food production. So, appropriate policies should be formulated to mitigate the antagonistic impact of natural hazards on rice-wheat production, ensuring food security via increasing food production (availability) and income (assess). Famers' awareness regarding climatic and natural hazards should be increased by strengthening the agricultural extension services. In addition, data availability on the forecast of climatic and natural hazards should be available to make the appropriate farming decisions in a period of climatic and natural hazards. Moreover, appropriate adaptation strategies should be designed for the mitigation of the adverse impact of these natural calamities. Effective weedicide and pesticides should be used to cope with insect, pest and biological diseases. Policymakers and breeders should focus on the development of new rice, as well as wheat varieties that consume less water and are resistant to climatic vulnerabilities. Therefore, there is a need for a new green revolution in the country; hence, increasing crop production may uplift the farmers from the vicious cycle of poverty, improving farmers' livelihood and ultimately ensuring food security.

***Authors contributions statement*:** Muhammad Usman: Planned, conceptualization, conducted the research, formal analysis, and writing – original draft. Asghar Ali: Supervision, helped in finalizing the research methodology, review and editing. Sarfraz Hassan: Provided guidelines during research work and proof read the manuscript. Muhammad Khalid Bashir: Helped in data analysis

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