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RESEARCH PAPER

Effects of Climate Change on Efficiency and Productivity of Wheat in Punjab, Pakistan

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ABSTRACT

The most common economic risk is the natural disaster that is considered deadly for humanity because of the tremendous loss of agricultural land and lives. In the global climate index, Pakistan is in the 5th position among the most affected countries of the world by climate change. It is also estimated that there would be an increase in the rise of temperature till 2025. In Pakistan, the most affected crops due to climate are many, but the most prominent among them is wheat; giving rise to the issue of a shortage of food for the population of Pakistan either due to floods or droughts. Whereas Pakistan's the 8th largest country on wheat production in the world. The current study target to focus on the factors affecting wheat production addressing climate conditions in one of the major provinces of Pakistan; Punjab. The study makes use of cross-sectional data and the secondary data was collected through a survey questionnaire designed to access factors (climate change) affecting the efficacy and productivity of wheat. The study was carried out on 70 participants from the Punjab Province, Pakistan. The responses were obtained from 70 farmers (participants) regarding their wheat production yearly, their land size, their profit and the effect of floods and droughts on their production process of wheat. From the responses obtained by the participants, it is concluded that 71.4 (71.4%) of the participant farmers agreed with droughts and floods affecting wheat crops. Whereas 97 (97%) agreed with the personal and economical loss they face because of floods and droughts.

Keywords: Droughts, Floods, Wheat Production

Introduction

In the Worldwide scenario, there are certain natural disasters that are considered the major reason for climate change. These include floods, droughts, storms and cyclones The typical catastrophe occurs as a result of exposing to certain kinds of risks, geographical location and the manner of living having no cultural, communities or continental boundaries (Daniell, 2016). The increasing seriousness of natural disasters caused gravity all across the globe. There is an increasing loss of agriculture and human lives (Ahmad D. A., 2021).

In the present world, a tremendous increase has been observed in catastrophe casualties such estimation regarding the casualties of catastrophe would be expected to twice by 2050 (Wilkinson E. &., 2014). The most common economic risk is the natural disaster that is considered deadly for humanity because of the tremendous loss of agricultural land and lives. In the global climate index, Pakistan is in the 5th position among the most affected countries of the world by climate change. It is also estimated that there would be an increase in the rise of temperature till 2025 (Sabiruzzaman, 2021)

In the coming years, the major causes of floods in Pakistan is the climate change affecting rural lifestyles and a reduction in the productivity of crops (Abid M. S., 2016)(Abid

et al., 2016; Ahmad & Afzal, 2021). There is an important dependency of the rural population on agriculture as Pakistan's agriculture recruit 43.5% of labor and almost 64% of the rural population relies on this agriculture for a living (PBS, 2021). This shows how agriculture is playing a crucial role in the economic stability of Pakistan. In Pakistan, the most affected crops due to climate are many, but the most prominent among them is wheat (Ahmad & Afzal, 2021) giving rise to the issue of a shortage of food for the population of Pakistan either due to floods or droughts. Whereas Pakistan's number on wheat production in the world is 8th (FAO, 2020).

Wheat also known as (Triticum Specie) is a widely known staple crop, providing food as well as energy due to having dietary fires. Wheat is considered one of the major crops all across the globe. It has been planned in different areas of the world. The estimation reported that almost 729 million wheat grains have been harvested by different countries around the globe (Food and agricultural organization, 2014). In the agricultural productivity of Pakistan, the contribution of the wheat crop is 9.2% and it shares almost 1% GDP of Pakistan (PBS, 2021). Pakistan's wheat production in 2020 was estimated at 25.248 million tons, lower in comparison to other countries of the world (PBS, 2021). The agricultural production of Pakistan is not as good as the rest of the developing countries. There are so many factors playing their roles in lower production. The highlighted factors include natural hazards farmers' illiteracy regarding the using old farming methods and the obstacle to the adoption of modern technology (Khajjak, 2022)

In Punjab Province, wheat production shares a crucial share of 77% across the country (among the rest of the three provinces). In a couple of decennaries, there is a co-occurrence of catastrophes due to natural disasters such as storms and floods resulting in an effect on the most crucial crop; wheat. Keeping the situation under consideration it is crucial to develop risk management strategies and policies to manage the outbreak and develop measures to cope with the issue of natural disasters (Kirkham, 2015).

Pakistan is one of the major developing countries which is fighting against major issues such as poverty and food shortage. It is one of the agricultural lands with an estimated 21% of GDP dependence on this sector of agriculture (Zhou et al., 2019). Almost 43.5% of the total jobs are available because of this sector. With regard to population count, Pakistan is in the 6th of rank among other countries. 61% of the total population of Pakistan lives in rural areas whereas the rest of the population (39%) lives in urban areas. The population has developed a dependency on this sector to earn bread for themselves and their families. Pakistan was playing its part to accomplish the food security arrangements where people will be provided with better health facilities until 2025. But the sudden flood of 2022 turned the table and affect the planning of Pakistan (survey, 2021).

Literature Review

Cereal grains have been an important source of calories for most of the human population. There are major and minor cereal grains. The major includes wheat and rice, and the minor includes barley and oats etc. Cereal grains provide almost 50% of the protein and 56% of energy to human beings who consume them. The contribution of wheat and maize is almost 713 million. It is contributing to 50% of the global production of cereal grains. The percentage should be increased to cater for the increasing demand of the globe till 2050 (Ray, 2013).

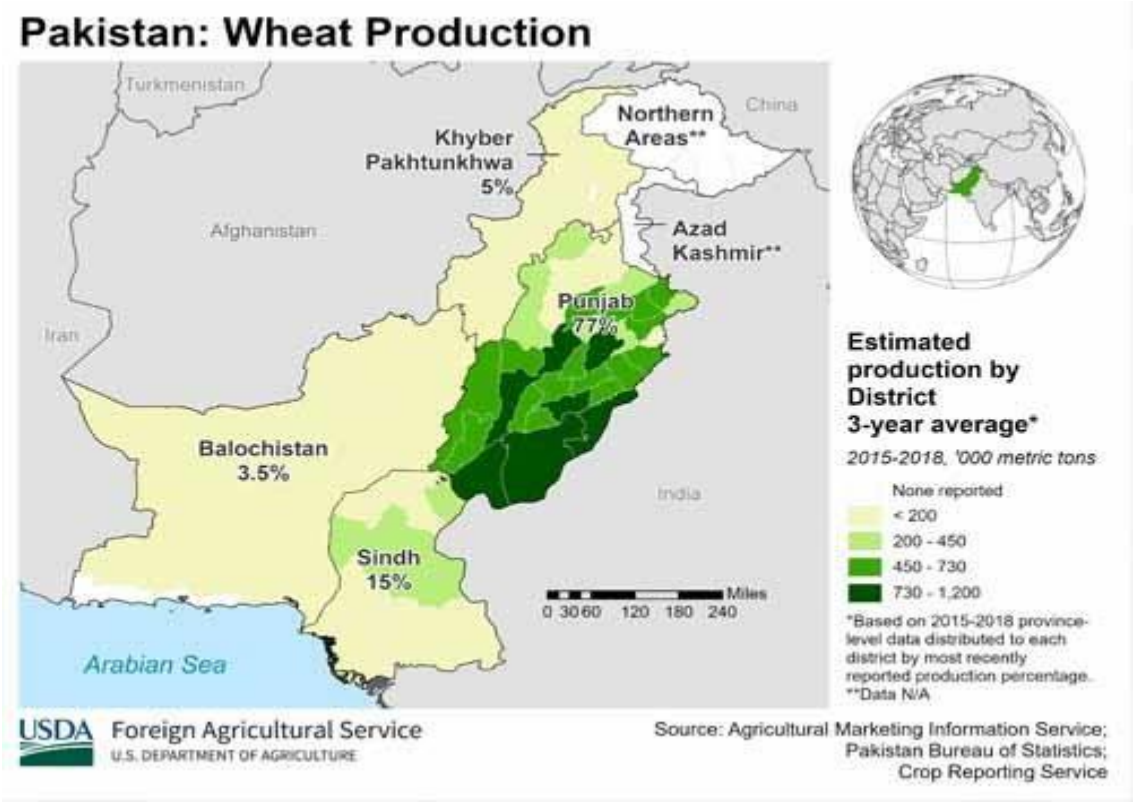

Figure 2 Highlighting Pakistan total Wheat Production

The map represented above throws light on the percentage of contributions of Provinces in the wheat production. KPK produce 5%, Baluchistan produce 3.5%, Sindh produce 15% whereas Punjab is dominant as it produced 77% of wheat.

In Pakistan, the cereal crops specifically the wheat crops are severely affected by floods and droughts almost every year (Ahmad & Afzal, 2020) promoting the issue of food shortage for the country's residents (GOP, 2020). Wheat is considered a staple diet for the Pakistani Population which is the reason it is considered the major food crop (FAO, 2020). The wheat crop of Pakistan contributes almost 1.8% of the GDP (PBS, 2021). According to the 77% of Punjab province wheat production, there has been an estimation of consecutive floods in the past years, affecting the crops, damaging farmer's property and posing a threat to the survival of humanity (Ahmad D. A., 2021).

The security of food has been a key factor towards sustainability in the SDGs of the United Nations (UN) that aimed to eradicate the issue of food shortage claiming to end the zero-hunger motto in the whole world by 2030. In order to accomplish this vision certain policies were made and certain steps were taken to accomplish this goal. Before targeting the issue of food shortage as an issue by United Nations (UN) the estimation according to the data of 1990-1992 there were a vast majority of people who were facing this issue but it has been reduced. Almost 2 million of the population benefited after making this SDG. In a couple of decades, it has been noticed that climate disasters were somehow controlled improving the condition of food shortage until 2019 (Fujimori, 2019).

Still, the whole situation imposed a threat and risk for Pakistan. There were certain acts that were causing the temperature to rise and thus affecting Pakistan. Pakistan has faced floods since 2013 because of this rise in global temperature and sudden change in the climate condition. Also, droughts specifically agricultural droughts are considered hazardous producing harsh environment, affecting the soil moister that is not enough for crops growth leading to a shortage of food (Fahad, 2019)

The floods occurred in 2010, then 2013, and 2015 they were considered the most severe form of floods in Pakistan's history with an estimated death rate of 2000 people. This is the major reason why people called Pakistan a Flood-prone country of the continent. Pakistan has been ranked 40th in terms of the death rate due to climate change in the Climate Risk Index for 2016. Pakistan was ranked 77th overall and 17th in terms of regions (the Asia & Pacific) because of the shortage of food due to the change in weather or climate conditions (GSFI ranking table, 2014). It is also estimated that Pakistan has been one the largest producer of cereals (including wheat) like India and still 500 million of the worlds are suffering from the tremendous issue of shortage of food (Asghar, 2013)

The report by the Sustainable development institute (SDI) highlighted that almost 49.8% of the total Pakistani population is faced with the issue of food shortage according to the survey report of 2009. Pakistan was also given the rank of 11th most insecure country with regard to the shortage of food (SDPI, 2019). The major behind this insecurity is the climate. There are five aspects to be considered regarding the security of food; including its production, its assessment of the people, its proper distribution, usage and cleanliness (FAO, 2015). The major reason for conducting the study is to analyze the major factors affecting wheat production. Climate change (the occurrence of floods & droughts) has been one of the major factors behind food issues for a couple of years. Pakistan is one of the countries harvesting the most important staple food wheat. Farmers start sowing it in the month of October to November and harvest it in the month of April and May. The sudden floods before harvest posed a threat and thus are responsible for the shortage of food in Pakistan (Ghaffar, 2014).

The current study target to focus on the factors affecting wheat production addressing climate conditions in one of the major provinces of Pakistan; Punjab. According to the economic survey report of Pakistan (2015), Pakistan contributes 90% of wheat production that is harvested solely by the farmers of the Punjab Province. The existing studies highlighted how wheat production is dependent on the climate. Different regions are areas were targeted with respect to the need of the time. To illustrate things in detail the researcher constructed a theoretical model to analyze things in a single frame.

Methodology

There are four provinces in Pakistan and Punjab shares 26% of the area with almost 53% of the population and thus has fertile land in terms of agriculture (farming) (PBS, 2020). The researcher chose the Punjab Province for the collection of data because of some major reasons mentioned ahead. Punjab makes 53% of the contribution to agricultural GDP. The total wheat production of the Punjab Province is 77% (PBS, 2020). In a couple of decades, the most affected crops of Punjab due to climate change were rice and wheat this was another reason the researcher opted for the Punjab province. Lastly, the provinces of Pakistan were affected due to the floods from 2010-2015 and the Punjab province was affected more badly and rigorously, causing destruction to the infrastructure (NDMA, 2019)

The existing studies were concerned with various factors responsible for affecting wheat production one of them was the climate. The researcher aimed to target how climate change caused the flood and affected the wheat productivity in Pakistan in the past years (on which almost the whole of Pakistan is dependent as a primary need of life). A questionnaire was designed to highlight 5 major themes driven by the literature regarding the wheat production mechanism and the factors affecting wheat production.

Construction of the Questionnaire

The tool was constructed keeping in view the agricultural condition of the Punjab Province, Pakistan specifically focusing on wheat production (Production behavior, area production & yield of wheat, structure of production, Producer price behavior) and the

effect of climate change (floods & droughts using linear binary regression model) on its production. The tool was comprised of 15 questions in general (attached in appendix A) including demographic variables, Wheat production, the risk of floods and droughts and their response towards it).

Data Collection

Area of the Study

The study makes use of cross-sectional data and the secondary data was collected through a survey questionnaire designed to access factors (climate change) affecting the efficacy and productivity of wheat. The study was carried out on 70 participants from the Punjab Province, Pakistan. Punjab is one of the second largest provinces after Baluchistan in terms of land. It has been estimated that most of the wheat production in Pakistan is done by the Punjab Province, this was the reason researchers utilized this province to highlight factors (climate change) affecting wheat production. The sample was selected based on the basis of probability sampling technique. The data was collected from farmers involved in wheat production. The survey questions were designed systematically including demographic information and the production of wheat and flood as a risk factors.

Results and Discussion

Production Behavior

Wheat is the crucial staple crop of Pakistan. Most of the contribution of wheat is made by Punjab Province. The agriculture sector is contributing differently every year. Wheat is a crucial crop of Rabi with a production of 8.1 % (27.293 million) according to the survey report of agriculture 2020 (Agriculture Statistics of Pakistan, 2015-2021). Wheat cultivation in 2021 was recorded as 7.41%. A further demonstration is given in Table 1.

Table 1
Production of agriculture (wheat) from (2015-2021)

Sector	2015	2016	2017	2018	2019	2020	2021
Agriculture	**2.13**	**0.15**	**2.18**	**4.00**	**0.56**	**3.31**	**2.77**
1. Crops	0.16	-5.27	1.22	4.69	-4.96	5.54	2.47
Important crops	-1.62	-5.86	2.60	3.56	-7.69	5.24	4.65
Other crops	2.51	0.40	-2.51	6.26	2.60	8.08	7.41
Cotton ginning	7.24	-22.12	5.58	8.80	-12.74	-4.82	-15.58
2. Livestock	3.99	3.36	2.99	3.70	3.82	2.10	3.06
3. Foresty	12.45	14.31	-2.33	2.58	7.28	3.60	1.42
4. Fishing	5.75	3.25	1.23	1.62	0.80	0.60	0.73

Source: Agriculture Statistics of Pakistan, 2015-2021 (Pakistan Bureau of Statistics)

Area Production & yield of wheat in Pakistan

The Area production covers the hectares and the change regarding wheat and highlights the production of wheat in this duration. The following table highlighted the area, production and wheat yield from the year 2010-2017 Source: (Chandio, 2018)

Table 2
Area, Production & Yield of Wheat Crop of Pakistan (2010-2022)

Years	Area		Production		Yield	
	(000) Hectares	Change (%)	(000) Hectares	Change (%)	(Kgs/Hec.)	Change (%)
2010-2011	8901	-2.5	25214	8.2	2833	11
2011-2012	8650	-2.8	23473	-6.9	2714	-4.2

2012-2013	8660	0.1	24211	3.1	2796	3
2013-2014	9199	6.2	25979	7.3	2824	1
2014-2015	9204	0.1	25086	-3.4	2726	-3.5
2015-2016	9224	0.2	25633	2.2	2779	1.9
2016-2017	9052	-1.9	26600	0.5	2845	2.4
2017-2018	9100	0.1	25100	3.6	2809.9	2.85
2018-2019	9070	-2.5	24300	5.61	2815.2	2
2019-2020	9223	5.3	26100	7.56	2820.5	4.77
2020-2021	9062	6.8	25535	9.51	2825.8	5.73
2021-2022	9229	0.1	25521	7.3	2831.1	2.4

Source: (PBS)

Production Structure of Wheat

The survey report of the Pakistan Census of Agriculture highlighted the fact that almost 84% of the farms are utilized for the production of wheat from 1980 to 1990. This contribution was measured on the basis of three divisions of land (small, medium, and large), represented in the following table. It also highlighted the idea that wheat has been an important dire need since the 1980s (Pakistan Census of Agriculture 1980 and 1990).

Table 3
Production of wheat from (1980-1990)

Size of farm	Total farms (1980 & 90)		Farms under wheat (1980 & 90)		Production '000 t (1980 & 90)	
Small farm (0.5 to 2 ha)	1,386,394	2,404,057	1,098,521	1,927,334	1,050	2,297
Medium farm (2 to 10 ha)	2,308,460	2,321,792	2,008,879	1,978,544	6,247	8,008
Large farm (10 to 60 above ha)	374,565	345,114	310,309	276,858	3,208	4,171

Source: Pakistan Census of Agriculture 1980 and 1990

Producer Price Behavior

A continuous trend has been observed in the price of wheat every year. The record of the last few years is represented in table 3

Logistic Binary Regression Model

The researcher utilized a logistic regression model in order to study the response set received by the participants. In the binary regression model, there is one dependent and more than one independent variable. The responses recorded by the respondents were Yes and No. The existing literature such as (Abid M. S., 2016) highlighted that it is the best model to be utilized for one dependent and more than one independent variable. Where Y demonstrates the dependent variable and X shows the independent variable.

(a) $\mathbf{Y = a + bX + e}$,

Table 5
Depicting Farmer's responses regarding the impacts of natural calamities (floods & droughts) on Wheat Production

Response	Frequency	Percentage
No Impact on Wheat production (=0)	20	28.5%
Have Impact on Wheat production (=1)	50	71.4%
Total	70	100%

Table 5 shows the answers given by the respondents regarding floods and droughts (Natural Hazards) on wheat production. The total Participants were 70. 20 participants go with "No Impact" with a percentage of 28.5 (28.5%) and a frequency of 20. Whereas the rest of the participants agreed "by choosing Yes" with a frequency of 50 and a percentage of 71.4%.

Association of Wheat Production and Natural Calamities

A strong association has been observed between natural calamities and wheat production. Existing literature highlighted how wheat production and structure have been evolving with reference to time. The researcher has demonstrated the record from 1980 to 2021 in the economic analysis. General wheat production could be observed from those sources; also, a drift could be observed regarding wheat production after facing floods or droughts. Table 5.6 highlight some of the responses collected by the researcher in the current study from Punjab Province, Pakistan. There were six major themes of the study analyzed next:

Conclusion and Recommendations

Punjab Province was selected because of its most contribution to wheat production as well as GDP (Gross Domestic Product). Punjab makes 53% of the contribution to agricultural GDP. The total wheat production of the Punjab Province is 77%. The researcher's aim was to highlight the facts regarding wheat production solely; and then the influence of natural hazards (such as floods & droughts) on wheat production in Punjab Province, Pakistan. The Linear Binary Regression model was analyzed to compute the Yes & No responses. A general analysis was done to compute wheat production and then the effect of floods and droughts on it. All the previous sources regarding agricultural information in Pakistan (from 1980 to 2021) were brought into consideration to develop an association. The themes generated through the literature review were incorporated into the questionnaire to drive out current wheat production and factors (floods & droughts) that affect wheat production. The responses were obtained from 70 farmers (participants) regarding their wheat production yearly, their land size, their profit and the effect of floods and droughts on their production process of wheat. From the responses obtained by the participants, it is concluded that 71.4 (71.4%) of the participant farmers agreed with droughts and floods affecting wheat crops. Whereas 97 (97%) agreed with the personal and economical loss they face because of floods and droughts. Other varieties of findings analyzed by the researcher demonstrate wheat production, its yield, structure and price behavior. The study should be analyzed on a large scale including all of the provinces of Pakistan with a few more factors (such as temperature) along with the percentage of each province to have an understanding of large-scale production and factors affecting wheat production in Pakistan. It will help to develop strategies so that farmers can implement them to cater for this issue and improve productivity.

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