

# Evidence-based impact of climate change on crops yields & social protection of the vulnerable rural communities through crop insurance management system in Punjab-Pakistan

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*Abstract: Punjab is Pakistan's largest province and has the major share in national agricultural production including food staples. Pakistan is the seventh most affected by climate change. Wheat production and a sizable swathe of the cultivated area of other crops have been devastated by first the heatwave in March-April 2022 and then heavy flooding in July-August 2022. Wheat crop is one of the major crops in Pakistan. It ensures food security for the population of 220 million. The per capita Wheat grain consumption in Pakistan is around 124 per kilogram per year which is highest in the world. Due to the heat wave in the months of March and April 2022, the production of wheat, the major staple crop, declined by 0.8 million tons as compared to last year and the average yield decreased by 1.4% per acre. Resultantly, Pakistan had to import wheat from the international market to fulfill its domestic needs. A total of 375,120 farmers in the Punjab were insured under the crop insurance program for the Wheat crop in Rabi 2021-22 season. The Government of Punjab subsidized this insurance program because crop insurance is not in the priority list of farmers due to unstructured rural economy, buying capacity and religious aspect. The Government provided an insurance premium subsidy of Rs. 450.0 million for the 375,120 farmers to the insurance company to provide yield loss coverage for Wheat crop. Based on the 7,349 Crop Cut Experiments (CCEs) in the 27 insured districts, Wheat crop claim was not registered because the decline in yield did not go beyond 10% of 10 years average yield. Similarly, the Rice crop is also one of the major crops cultivated in the Punjab during the Kharif season. In 2021, Rice crop was cultivated on 5.9 million acres (2.3 million hectares) in the Punjab with a total production of 5.3 million tons with an average yield of 22.40 Maund per acre (CRS, 2021). Under the crop insurance program in Punjab, 100,184 rice growers to protect them from the yield losses due to climatic events for which a substantial amount was provided to the insurance companies as premium in the form of subsidy by the Government of the Punjab. The Crop Reporting Service conducted 2,266 CCEs in the Rice field of the 14 districts out of 27 for the Kharif 2022 season. Based on the CCEs, the yield of Rice crops shown a rise in yield due to substantial rains. The Monsoon during 2022 was beneficial for the rice growers because this cash crop is water loving and grows well in high precipitation and hence no claim was registered too. Cotton is also one of the major cash crops of Pakistan and it is mainly sown in Punjab and Sindh province. Pakistan is the fourth largest producer of cotton. Last year cotton was cultivated on 3.8 million acres (1.5 million hectares) in the Punjab and the production was 5.04 million bales with an average of 15.84 Maund per acre (1 Maund = 40kg). In the months of July and August, Punjab province received extraordinarily heavy rainfall that damaged around 654,000 acres (264,664 hectares) of cultivated crops posing a cumulative loss of USD 362 million in loss of crop only. The estimated loss from the recent floods is around US\$ 32 billion. Under the crop insurance program, the Government of Punjab insured 124,816 cotton growers mainly in the Southern Punjab districts, the main cotton hub of the province.*

*For Rice and Cotton crop, the Government of Punjab provided the insurance premium of Rs. 500.0 million to the insurance companies to provide yield loss protection to the small and subsistence farmers in the province. The CRS conducted 3,380 CCEs for the cotton crop in around 13 out of 27 insured districts. Based on the CCEs, the cotton crop yield declined substantially as compared to the last 10 years average yield. In some parts, the yield declined by 50% in total due to rains and floods hence triggering a claim payout for the cotton growers. Out of 124,816 cotton insured farmers, the Government of the Punjab is compensating 83,502 insured cotton growers for the yield losses due to massive rains and floods with US\$ 3.3 million (Pkr 746 million) through insurance companies. These losses are being paid through the Branchless Banking Operators hired by the insurance companies to ensure the transparency in the disbursement process because only insured farmers will get the compensation after his/her biometric verification at the collection center.*

*Crop insurance program has been in place at a small level in the Punjab for the last five years, but it has not exposed to such calamities before.*

*From the above facts and figures it is evident that climate change has severely affected the crops yield in the Punjab province of Pakistan during 2022. The crops' yield declined first due to severe heat wave and then torrential rains and floods. The crop insurance program in Punjab based on Area Yield Index Insurance is an example of how these kinds of risk management tools can lessen the financial burden of the government and provide much-needed financial support to the most vulnerable rural communities in the country. Crop Insurance Program in Punjab has also proved to be an effective relief and compensation post disaster risk management strategy with an objective to enhance the resilience of vulnerable farming / rural community in the province. Before the crop insurance program, there was not a single significant risk management tool tailored to provide support to the farmers affected by the vagaries of climate change. The Government of the Punjab has at least endeavored to help and support the farmers in time of need through crop insurance program despite financial constraints. However, the scale of the program should be enhanced by the provision of more funds so that a major chunk of the farmers can benefit from it. Since Pakistan is one of the most affected countries in world due to climate change hence program and interventions like crop insurance are now a need and essential requirement. The Crop Reporting Service of Agriculture Department Government of the Punjab is the implementing agency for the crop insurance program in the Punjab province. These extreme events have now created a need for a comprehensive crop and livestock insurance program at national level because the governments alone cannot manage such post-disaster losses. Further, it is evident that the Area Yield Index Insurance (AYII) Model is best suited for the Punjab province in the given heterogeneous cropping pattern and inconsistent farm management. The same model can be implemented in other provinces of Pakistan by incorporating local requirements. Further, to reduce the basis risk associated with AYII model especially when average yield is computed for a larger geographical unit, remote sensing technology can be used to periodically monitor the crop health and compute the crop yield for smaller geographic units.*

*Keywords: Crop Insurance, Climate Change, Heat Wave, Floods in Pakistan, Area Yield Index Insurance*

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## INTRODUCTION

**B**etter weather conditions and climate is very essential and has significant impact of the agricultural productivity and livestock (Aydinalp, & Cresser, 2008). The primary and foremost determinant of agricultural productivity is climate (Adams, R. M., Hurd, B. H., Lenhart, S., & Leary, N. (1998). The agriculture sector is totally dependent of how the climate behaves (Arunanondchai, P., Fei, C., Fisher, A., McCarl, B. A., Wang, W., & Yang, Y. (2018).

Agriculture and livestock vulnerability is an established fact in the literature that means any variation or change in the temperature, precipitation, humidity, will have direct and significant impact on crops yields (Kurukulasuriya, P., & Rosenthal, S. 2013).

Climate change is certainly impacting the crops' yield across the world and will be for our

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future generations regardless of the efforts the average global temperature will rise by 2 Degree Celcius by 2100 (Sokolov et al. 2009). The rate of climate change has increased during the past many decades due to increase in anthropogenic activities such as deforestation, industrialization, and urbanization (Mahato, A. (2014).

The impact of climate change is not limited to some countries or continents but is a global phenomenon and it has severely impacted South-Asia, home to around 2 billion human beings. In recent past and present, there is a significant rise in air temperature and occurrence of extreme weather events in this part of the world (Sivakumar, M. V., & Stefanski, R. (2010). The occurrence of extreme events like heat wave and increased variability in precipitation is now a reality. There is a direct relation between the rise in air temperature and crops yield and water availability (Sivakumar, M. V., & Stefanski, R. (2010). Variation in the climate is a serious threat to the crops and has huge implications for global food security (Knox, J., Hess, T., Daccache, A., & Wheeler, T. (2012).

Climate change is the persistent change in weather patterns over a long period of time due to increased anthropogenic activities and it has impacted the global economy negatively (Chandio, A. A., Jiang, Y., Rehman, A., & Rauf, A. (2020). The impact of the climate change can vary the output by 60% (Afrin, S., Haider, M. Z., & Islam, M. S. (2017).

### AGRICULTURE IN PAKISTAN

Pakistan is a home to 207 million people out of which 132.1 million resides in the rural areas (Government of Pakistan Census 2017). Like many other developing countries, Pakistan's economy is heavily dependent on its agriculture sector because it is the only sector that has ensured food security to millions. According to the government statistics, agriculture sector contributes around 20% towards the Gross Domestic Product (GDP) of the country (Economic Survey of Pakistan, 2022). Around 70% of the population in Pakistan looks towards the agriculture sector for livelihoods and it also a source of employment for around 38% of the labor force (Economic Survey of Pakistan, 2022). During the financial year, the agriculture sector performed better as compared to previous years after the Covid-19 pandemic as it recorded a growth of more than 4% (Economic Survey of Pakistan, 2022). Pakistan produced ample Wheat to sustain its large portion of the population with a few millions of Wheat shortage. By and large, Pakistan's agriculture is to be credited for ensuring food security. Pakistan exported about US\$ 4.4 billion during the FY 2020-21 that has 22.49% in value addition. Pakistan's agriculture is largely characterized by major five (5) crops i.e., Wheat, Sugarcane, Cotton, Rice and Maize. Although, apart from these major crops, Pakistan is a major player in the fruit export market. Pakistan is 4th largest producer of Cotton, Chickpea, 5th largest producer of Sugarcane, 6th largest producer of Mango, Dates, Apricot, 8th largest producer of Wheat, by producing 27 million tons, 10th largest producer of Rice crop and 36th largest in terms of area (AARI, 2022). In the given scenario, any variability in the climate will have a sharp and significant impact on the agriculture sector, the backbone of the country's economy.

### IMPACT OF CLIMATE CHANGE ON AGRICULTURE IN PUNJAB-PAKISTAN

Climate change is a global phenomenon and Pakistan certainly joins the list of those countries affected by this. Climate change is a direct result of extensive disturbance to the natural ecosystem (Kohler T, Maseli D (2009).

Pakistan is one of the most affected countries in the world in terms of climate change. The variability in climate adversely affecting agriculture, water availability nutrition, soil degradation and is responsible for scores of other socio-economic indicators (Fahad, S., & Wang, J. (2020). Amongst the South Asian countries, Pakistan is one of the most affected by the vagaries of climate change translated into abrupt high temperatures, long spells of droughts and many other extreme events (Fahad, S., & Wang, J. (2018).

For Pakistan, climate change has resulted in extensive floods, heavy rains, droughts and high temperatures (Fahad S, Wang J (2018). The climate change has drastically impacted the agriculture sector including livestock, weather patterns, food and water shortages in Pakistan Hussain, M., Butt, A. R., Uzma, F., Ahmed, R., Irshad, S., Rehman, A., & Yousaf, B. (2020). Another study, based on empirical models, has predicted the due to climate change Pakistan will suffer an induced loss to Rice and Wheat production of about US\$ 19.5 billion by 2050 and this will be a heavy blow to the

country's fragile economy (Khan, M. A., Tahir, A., Khurshid, N., Husnain, M. I. U., Ahmed, M., & Boughanmi, H. (2020). Similarly, the rice crop in Pakistan is experiencing the vagaries of climate change and yield of some of the varieties of rice is on decline due to abrupt weather patterns (Khan, N. A., Gao, Q., Abid, M., & Shah, A. A. (2021).

Heat wave, yet another factor of climate change has impacted Pakistan over past many years. Research studies have underscored heat wave as a continuous phenomenon for major parts of Pakistan. Research findings reveal that Pakistan has faced heat waves events in the past from 1997-2015 and based on the model, it is projected that heat wave events will drastically increase in the coming years (Nasim, W., Amin, A., Fahad, S., Awais, M., Khan, N., Mubeen, M., ... & Jamal, Y. (2018). The study also revealed that heat wave events are most likely to increase in Southern part of the Punjab province in future. Further heat accumulation in Monsoon season will adversely affect the agriculture sector of the country (Nasim et al., 2018).

In another research study, the General Circulation Models (GCMs) reveal that the heat wave events are most likely to increase up to 12 events per year and the length will also increase by 100 more days a year (Khan et al., 2020). Extreme climatic conditions due to abrupt weather patterns have negatively affected the yield on Maize crop in the Punjab (Imran et al., 2018).

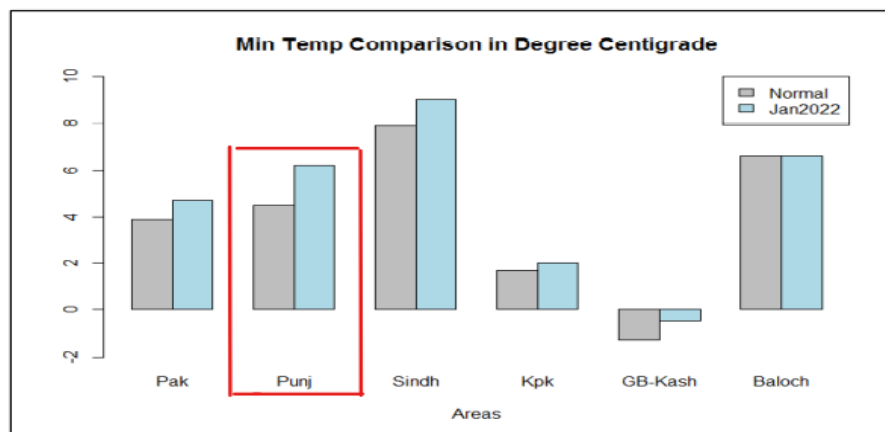
Punjab province is one of the most cultivated and fertile lands of Pakistan. It is also the biggest province in terms of population in Pakistan. The total area of Punjab-Province is around 42.5 million acres. Out of these 12.3 million acres are uncultivated and 30.22 million acres are cultivated mainly predominantly occupied by five major crops i.e., Wheat in Rabi season, Cotton, Sugarcane, Maize, and Rice in Kharif season (CRS, 2022). There are two major seasons in the Punjab, Kharif & Rabi. The Kharif season starts from 1st April to 30th September while Rabi season starts on 1st October till 31st March. Wheat crop is the largest cultivated crop during the Rabi season (Syed, Raza, Bhatti & Ehsan 2022). Last year in Punjab only, Wheat was sown on 16.21 million acres which is about 54% of the total area cultivated in the province of Punjab (CRS, 2022). Wheat production stood at 20.9 million tons, which is 4.2% less than the previous year. Similarly, the average yield of Wheat crop during Rabi 2022 season stood at 30.89 which is 1.4% down as compared to the last year average yield. This clearly indicates the impact of heat wave on Wheat crop (CRS, 2022).

In January of 2022, the Rabi season witnessed above normal weighted rainfall in the Punjab that was 55.7 mm against the normal rainfall of 15.6 mm (NWFC, 2022). But in February, the weighted rainfall declined by 61% (8.9 mm) as compared to normal rainfall of 23.0 mm. In March, Punjab province witnessed a decline in weighted rainfall by 65% (9.8mm) as compared to 28.0 mm. Similarly in April 2022, the Punjab received less rain of about 2.3 mm (-89%) against the normal weighted rainfall of 20.6 mm (NWFC, 2022). This was due to abrupt change in weather patterns and climate change.

The sudden rise in temperature during Rabi 2022 season also adversely affected the yield of Wheat crop in the Punjab (CRS, 2022). In the months of January and February, the mean minimum temperature in the Punjab province remained above the normal (NWFC, 2022).

**Figure 1:** January Minimum Temperature Comparison 2022.

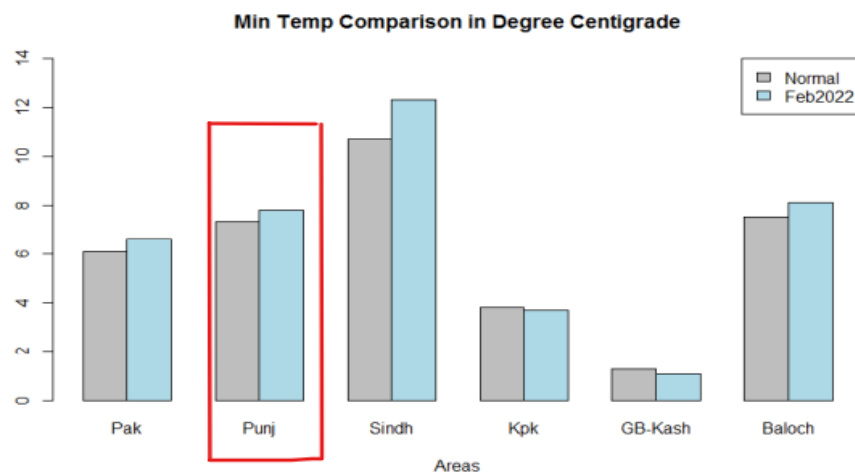
Source: <https://nwfc.pmd.gov.pk/new/monthly-reports.php>



**Figure 2:** February Minimum Temperature Comparison 2022.

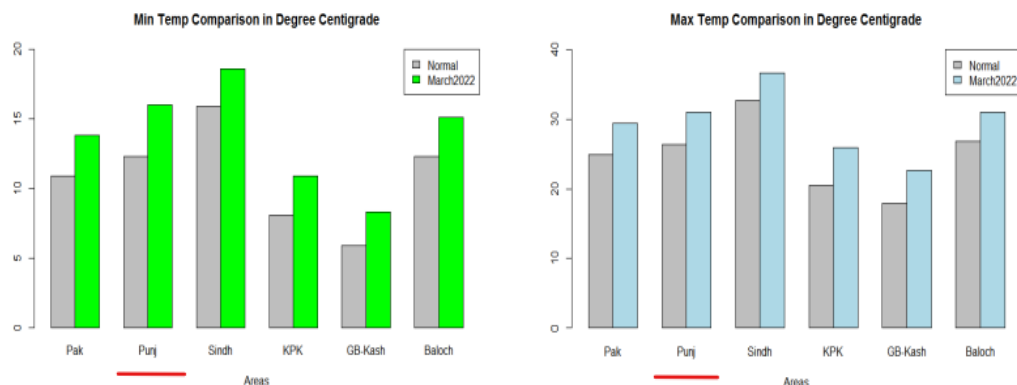
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Source: <https://nwfc.pmd.gov.pk/new/monthly-reports.php>

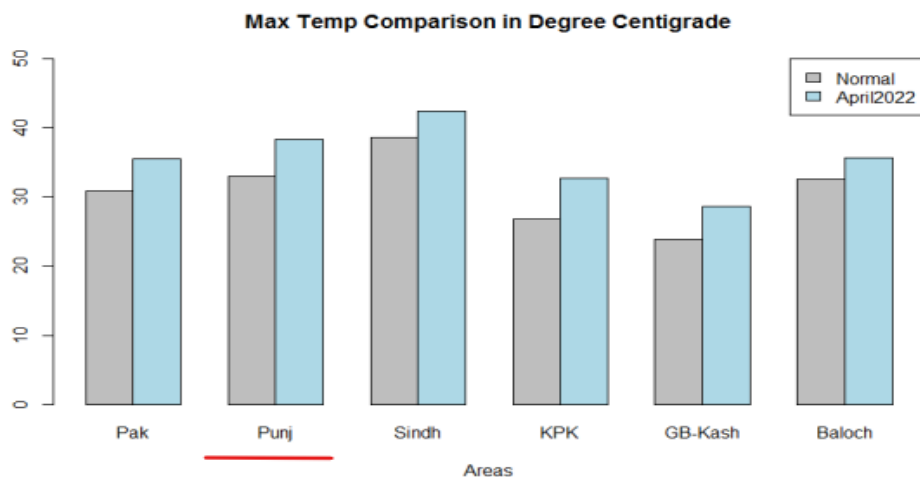


**Figure 3:** March Minimum & Maximum Temperature Comparison 2022.

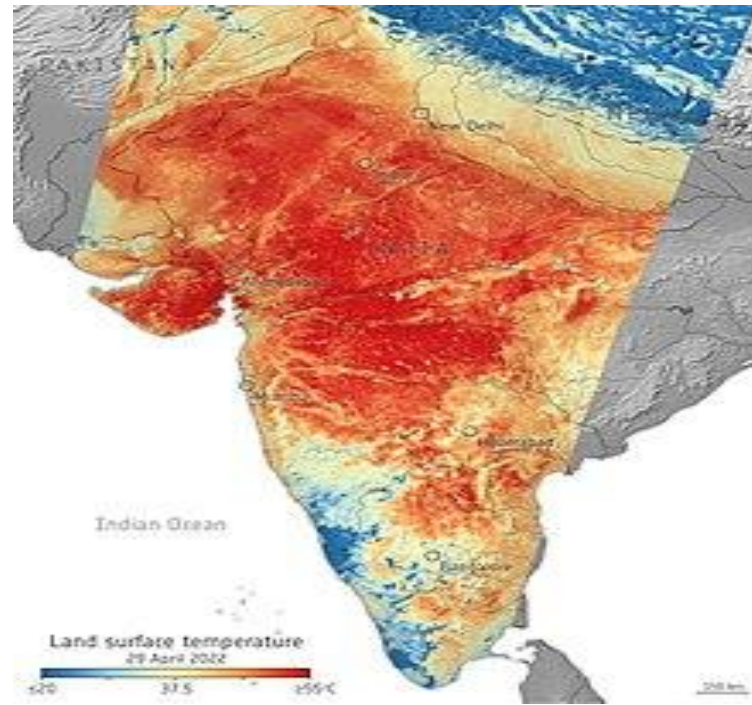
Source: <https://nwfc.pmd.gov.pk/new/monthly-reports.php>



**Figure 4:** April Maximum Temperature Comparison 2022. Source: <https://nwfc.pmd.gov.pk/new/monthly-reports.php>



**Figure 5:** Land Surface Temperature in Pakistan-India April 2022.



In the month of April 2022, temperature in Pakistan reached 49 degrees Celsius. Heat wave resulted in rise in temperature coupled with less rainfall in January to April 2022 in Rabi season, affected the production and average yield of Wheat crop. The recent heat wave has posed a serious threat to the food security globally and Pakistan is not an exception. The rise in temperature has a negative impact on the production and yield of Wheat, Rice, Maize, and other crops (abbas, 2022). Rise in temperature reduces crop production (Fatima et al., 2022).

In South-Asia, heat wave has significantly decreased the rainfall (UNDP, 2022). Pakistan is ranked at 15th place on climate related risk on a overheated planet that is facing an economic loss 25% of its Gross Domestic Product (UNEP, 2022).

The Wheat crop is usually harvested in April in major parts of the Punjab and heat wave has negative impact on the crop production and yield (CRS, 2022). Wheat crop is one of the major crops in Pakistan. It ensures food security for the population of 220 million. The per capita Wheat grain consumption in Pakistan is around 124 per kilogram per year which is highest in the world (USDA-2020).

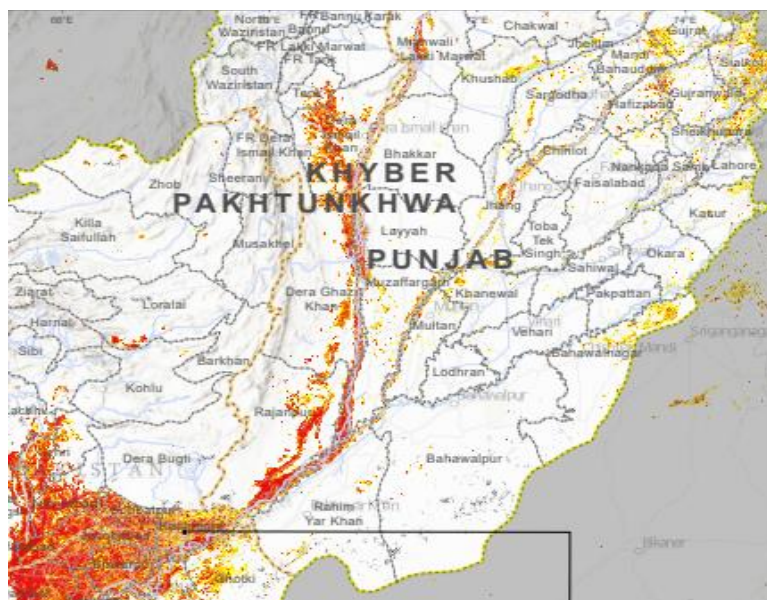
On the contrary, in June 2022, Punjab province received more rain than normal. During June 2022, rainfall recorded at 62.1mm against 29.4mm normal showing an increase of 111%. Similarly in the month of July 2022, Punjab province received 224.3 mm of rainfall that was 116% higher than normal weighted rainfall for the same month. In the month of August 2022, the province witnessed rainfall of 141.7 mm against the normal rainfall of 93.3mm which is 52% more (NWFC, 2022).

These unprecedented rainfall in the province impacted a large segment of cultivated areas in the province. Rains and massive water flow from the upper parts of the country resulted in urban and rural flooding, worst of its kind in the history of Pakistan and broke 30-year record. The main reason behind these havoc rains is climate change that resulted in melting of glaciers along with massive rains. (Pakistan Monsoon Floods 2022). Pakistan is one of the top ten affected of climate change while its contribution towards climate change is 0.8% in carbon footprint that is negligible (USIP, 2022). Pakistan has suffered a massive loss due to recent floods and as per the estimates, the economic loss is more than USD 40 billion (Daily times, 2022). A huge area submerged under water during the massive flooding in Pakistan (UNDP, 2022). Melting of the glaciers have also contributed to the flooding in Pakistan (Jones, 2022).

**Figure 6:** United Nations Satellite Centre (UNOSAT).  
Satellite Data: NOAA-20/VIIRS. Imagery Date: 03 to 23 Aug. 2022. Resolution: 375 m



EVIDENCE-BASED IMPACT OF CLIMATE CHANGE ON CROPS YIELDS & SOCIAL  
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Punjab faced two extreme events within a span of 5-6 months starting from an unprecedented heat wave to colossal floods. Heavy rainfall in the months of June till August 2022 resulted in massive floods that washed away everything including crops. Cotton, the major cultivated cash crop was badly affected by heavy rains and the floods in almost all parts of the Punjab. Cultivated in Kharif season, Cotton crop has a huge significance due to its demand both in the local and international market. Pakistan is the fourth largest producer of cotton (huli, Jarwar, Wang, Wang, & Ma, 2018). Last year cotton was cultivated on 3.8 million acres (1.5 million hectares) in the Punjab and the production was 5.04 million bales with an average of 15.84 Maund per acre (1 Maund = 40kg) (CRS, 2021). Similarly, the Rice crop is also one of the major crops cultivated in the Punjab during the Kharif season. In 2021, Rice crop was cultivated on 5.9 million acres (2.3 million hectares) in the Punjab with a total production of 5.3 million tons with an average yield of 22.40 Maund per acre (CRS, 2021).

Due to high rainfall during Kharif 2022 season resulted in huge loss to Cotton crop in the Punjab. According to the estimates of damage that the rainfall and floods have caused to Cotton crop was 350,992 acre (142,041 hectare) and a financial loss of Rs. 62 billion (USD 278 million) (CRS, 2022). This is a huge loss to the economy as well as to the farming community. Overall, 654,000 acres (264,664 hectare) of standing crops were lost resulting in financial loss of PKR 81 billion (USD 364 million).

**Figure 7: Damage assessment report of all crops in the Punjab due to rains & floods**

Flood Damage Impact assessment							
Department	Crop Reporting Service, Agriculture Deptt						
Date	09-09-2022						
Concerned Secretary							
Location / District	Population Affected	Affected Asset Type (i.e. Road, Bridge, Building, crop, livestock, conveyance, drainage network etc)	Unit for Asset i.e. Km / Number / Acre etc	Total affected asset	Extent of Damage (High / Medium / Low)	Financial Implication / Estimated Cost	Basis for estimated cost / Remarks / Comments
Mianwali	864	Cotton	Acre	1,200	High	238,920,000	Rs.11000/40 kg
Jhang	648	Cotton	Acre	800	High	147,840,000	do
Pakpattan	77	Cotton	Acre	170	High	33,000,000	do
Multan	3,258	Cotton	Acre	3,620	High	699,600,000	do
Muzaffargargh	14,261	Cotton	Acre	26,410	High	5,085,960,000	do
D.G. Khan	73,658	Cotton	Acre	81,842	High	15,847,920,000	do
Rajan Fur	131,013	Cotton	Acre	145,570	High	28,230,840,000	do
Bahawalpur	774	Cotton	Acre	1,720	High	327,360,000	do
R.Y. Khan	7,484	Cotton	Acre	20,790	High	4,016,760,000	do
Bahawalnagar	30,992	Cotton	Acre	68,870	High	13,341,240,000	do
Total	263,029	Cotton	Acre	350,992	High	67,969,440,000	do
Muzaffargargh	9,979	Sugarcane	Acre	12,320	Medium	231,360,000	Rs.240/40 kg
D.G. Khan	2,052	Sugarcane	Acre	2,850	Medium	53,520,000	do
Rajan Fur	32,538	Sugarcane	Acre	40,170	Medium	754,200,000	do
Total	44,569	Sugarcane	Acre	55,340	Medium	1,039,080,000	do
Muzaffargargh	3,326	Rice	Acre	4,620	Medium	241,400,000	Rs.1700/40 kg
D.G. Khan	50,746	Rice	Acre	70,480	High	3,670,300,000	do
Rajan Fur	14,537	Rice	Acre	32,304	High	1,684,700,000	do
Total	68,609	Rice	Acre	107,404	High	5,596,400,000	do
Muzaffargargh	96	Maize(Autumn)	Acre	425	High	43,350,000	do
D.G. Khan	206	Maize(Autumn)	Acre	915	High	93,330,000	do
Rajan Fur	374	Maize(Autumn)	Acre	1,660	High	169,320,000	do
Total	675	Maize(Autumn)	Acre	3,000	High	306,000,000	do
Mianwali	881	Moong	Acre	979	High	37,800,000	Rs.4800/40 kg
Muzaffargargh	158	Moong	Acre	350	Medium	13,440,000	do
Layyah	3,239	Moong	Acre	4,000	Medium	152,400,000	do
D.G. Khan	1,063	Moong	Acre	2,360	High	90,480,000	do
Rajan Fur	11,970	Moong	Acre	13,300	High	509,520,000	do
Total	17,310	Moong	Acre	20,989	High	803,640,000	do
Muzaffargargh	144	Seasame	Acre	1,068	Medium	60,375,000	Rs.10500 / 40 kg
Layyah	5,515	Seasame	Acre	12,256	Medium	706,125,000	do
D.G. Khan	2,937	Seasame	Acre	16,314	High	934,500,000	do
Rajan Fur	34	Seasame	Acre	382	High	22,050,000	do
Total	8,630	Seasame	Acre	30,020	High	1,723,050,000	do
Mianwali	57	Fodder	Acre	635	High	52,387,500	Rs.275 / 40 kg
Muzaffargargh	567	Fodder	Acre	6,300	High	519,750,000	do
Layyah	270	Fodder	Acre	3,000	Medium	247,500,000	do
D.G. Khan	4,151	Fodder	Acre	46,120	High	1,831,500,000	do
Rajan Fur	2,718	Fodder	Acre	30,200	High	1,278,750,000	do
Total	7,763	Fodder	Acre	86,255	High	3,929,887,500	do
G.TOTAL	410,585		Acre	654,000		81,367,497,500	

Source: Crop Reporting Service, Agri. Deptt. Punjab

Source: Crop Reporting Service, Agri. Deptt. Punjab

## Objectives

The objective of the research article is to highlight the impact and significance of risk management programs for the farming community in the Punjab-Pakistan. In the Punjab province, crop insurance program is in place for the last five years, but it has not been exposed to such extreme climatic events like that happened in March-April 2022 and unprecedented floods in Pakistan during Monsoon season, June-September 2022.

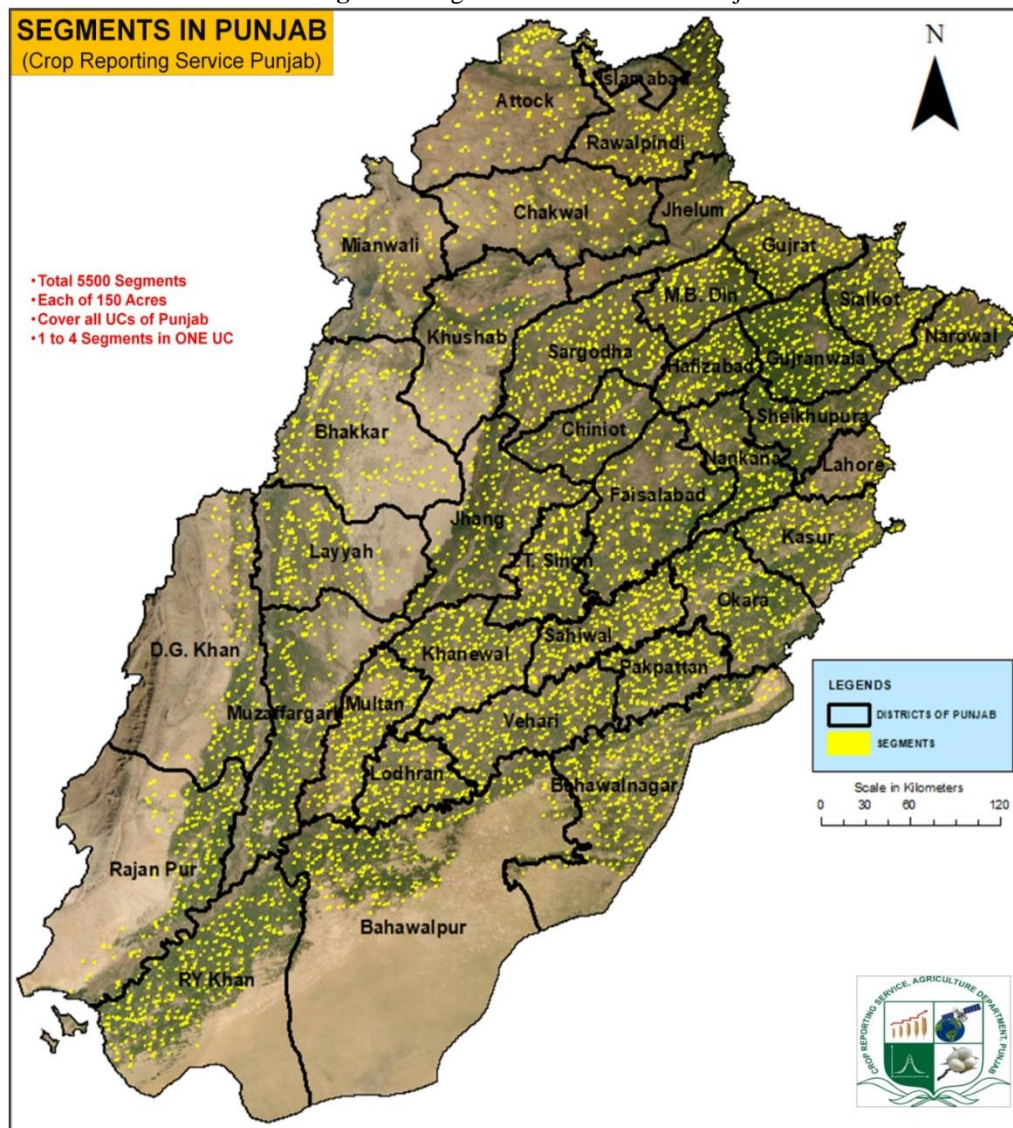
## METHODOLOGY

The Crop Reporting Service of Agriculture Department Government of the Punjab conducts Crop Cut Experiments (CCEs) in the province to estimate the average yield and production of the crops including orchards and vegetables. These experiments are based on objective and quantitative to assess the yield of the insured crops. The CCEs are conducted all over the province and vary a bit depending on the cultivated area in a district under a particular crop for which the CCEs are being executed. The selection of target points is derived from automated computer assisted Systematic Random Sampling (SRS) to ensure no human bias in the selection of the experiment sites. The enumerator conducts the experiments in his/her allocated segment of 150 acres (60 hectares). From each segment, two plots are harvested of 8 feet into 6 feet.

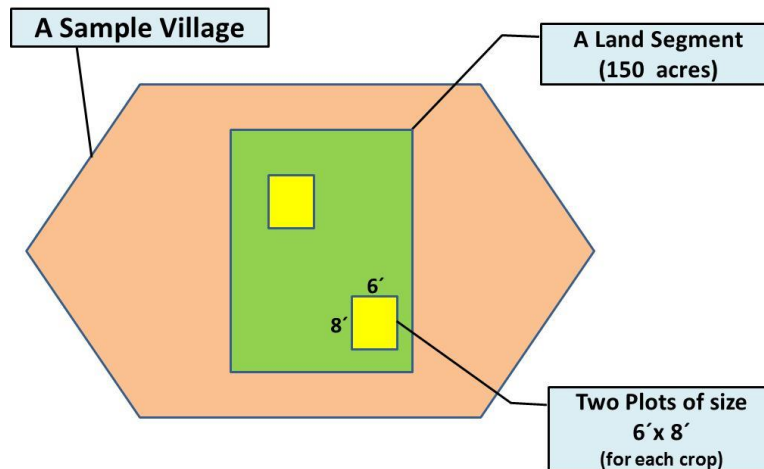


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**Figure 8:** Segment locations in the Punjab



**Figure 9:** Demarcation of harvesting sites



The produce from each plot is then weighted and overall yield of that area (tehsil/district/division, administrative areas) are calculated. The results of each plot harvested are shared electronically through a template to the higher tier starting from Tehsil to District and Division. All these reports are consolidated to estimate the area, yield and production of each crop at provincial level.

## FINDINGS

For Pakistan, climatic risks pose a serious concern for all especially the rural community who are the most vulnerable. Until recently, the farming community lacked the financial inclusion and have to cope with the challenges like floods, locust heat wave all alone and for the government, there was no systematic mechanism to reach out to these vulnerable communities in need. These climatic risks have constrained the farming community to adopt risk management strategies to overcome such climate change risks (Ahmad, & Afzal 2022).

The Government of the Punjab initiated a comprehensive crop insurance program (Abbas, 2020). Crop insurance can be the most efficient and useful tool for mitigating the natural risk to the agriculture section in Pakistan (Fahad & Jing, 2018). In Punjab, crop insurance is one of the most effective risk management tools for the marginalized farming community (Abbas, 2020). The Crop Reporting Service (CRS) Agriculture Department has the mandate to estimate yield for each crop cultivated in the province. Further the department is also the implementing body of the crop insurance program in the Punjab province of Pakistan.

During the last five years, 1.48 million subsistence farmers (less than 5 acres of land) were provided protection for crop yield under crop insurance program. After Covid-19, year 2022 happened to be the worst for Pakistan as it characterized by heat wave and massive floods. Wheat crop witnessed dip in average yield and production due to recent heat wave but that did not cross the 90% yield benchmark and no claims were triggered. A total of 375,120 farmers in the Punjab were insured under the crop insurance program for the Wheat crop in Rabi 2021-22 season. The Government of Punjab has subsidized this program because crop insurance is not in the priority list of farmers due to unstructured rural economy, buying capacity and religious aspect. The Government provided an insurance premium subsidy of Rs. 450.0 million for the 375,120 farmers to the insurance company to provide yield loss coverage for Wheat crop. During the months of February, March and April 2022, Pakistan witnessed an unprecedented heat wave event that affected the overall Wheat crop in the Punjab. The Crop Reporting Service of Agriculture Department Punjab conducted 7,349 CCEs in the 27 insured district of the Punjab. The Wheat crop yield is insured at 90% of the last 10 years average yield. Based on the CCEs results, it was observed that the yield at some of the location went down by 9% in Sharqpur of Sheikhpura district, 9.9 % in Tehsil Sahiwal of Sargodha district, 7% in Arifwala Tehsil of Pakpattan district, and 4% in Noorpur Thal of Bahawalpur district from the 10 years average yield at Tehsil level. This indicates that heat wave had the impact on the Wheat yield during 2022 season but that was not that high to the extent to trigger the claim pay out in the province. But at provincial level the yield of Wheat declined by 0.8 million tons as compared to last year and the average yield decreased by 1.4% per acre (CRS, 2022).

Torrential rains and floods washed a large, cropped area including cotton that was insured under crop insurance program. The Agriculture Department as a pre-disaster management strategy insured 225,000 farmers against the premium amount of Rs. 500 million in the month of June 2022. Out of these 225,000, insured Cotton growers were 124,816 while Rice growers were 100,184. The CRS conducted physical yield estimation experiments for Cotton and Rice crops that were insured under the program. The field staff of CRS executed 2,395 crop cut experiments in the Cotton zone of Punjab province. The benchmark for Cotton is adjusted at 80% of the last 10 years average yield under the Area Yield Index Model. Based on the crop cut experiment for the Cotton crop it is now evident that the crop suffered a massive blow from recent floods. In most areas, the yield of cotton crop declined by 40 to 50% against the last 10 years average yield posing a huge financial loss to the vulnerable rural community in the Punjab. However, Rice did not suffer any loss because it is a water loving crop.

The sum insured for Cotton crop was Rs. 50,000 per acre (US\$223/acre). Based on the Tehsil (3rd administrative unit in Punjab) average yield results derived from crop cut experiments, the aggregate financial loss occurred to cotton crop yield is Rs. 746 million (US\$3.3 million). The affected insured farmers in the claim triggered areas are 84,165 out of 124,816 total insured farmers.

# EVIDENCE-BASED IMPACT OF CLIMATE CHANGE ON CROPS YIELDS & SOCIAL PROTECTION OF THE VULNERABLE RURAL COMMUNITIES THROUGH CROP INSURANCE MANAGEMENT SYSTEM IN PUNJAB-PAKISTAN

The Crop Reporting Service of Agriculture conducted 3,380 crop cut experiments in the Punjab for cotton crop. The insurance claim is triggered if the average yield of crop in a Tehsil, declines beyond 20% of the 10 years average yield of that specific Tehsil. The difference in actual yield and the percentage decrease from the benchmark is compensated for by the concerned insurance company.

**Table 1:** Summary of impact of rain & floods on insurance claims. Source: Crop Reporting Service, Agriculture

IMPACT OF FLOODS/RAINS ON INSURANCE CLAIMS							
Sr. No.	Insurance Company	Total Farmers Insured	Total Premium Paid (Rs. Mil)	Total Crop Cut Experiments	Beneficiary Farmers Insured in Affected Tehsils		Total Claims (Rs. Mil)
					Cotton	Rice	
1	The Askari Insurance Company Ltd.	75,000	166.6	3,380 Cotton	34,000	0.00	267.25
2	The United Insurance Company	150,000	333.3	2,266 Rice	49,502	0.00	478.70
Total		225,000	499.9	5,646	83,502	0.00	745.95

The insurance companies contact the insured affected farmers and transfer the claim amount against Computerized National Identity Card (CNIC) which is unique, and farmers draws the claim amount after biometric verification to ensure transparency and immediate relief.

## CONCLUSIONS

From the above facts and figures it is evident that climate change has severely affected the crops yield in the Punjab province of Pakistan during 2022. The crops' yield declined first due to severe heat wave and then torrential rains and floods. Crop Insurance Program in Punjab has proved to be an effective relief and compensation post disaster risk management strategy with an objective to enhance the resilience of vulnerable farming / rural community in the province. Before the crop insurance program, there was not a single significant risk management tool tailored to provide support to the farmers affected by the vagaries of climate change. The Government of the Punjab has at least endeavored to help and support the farmers in time of need through crop insurance program despite financial constraints. However, the scale of the program can be enhanced by provision of more funds so that a major chunk of the farmers can benefit from it. Since Pakistan is one of the most affected countries in world due to climate change hence program and interventions like crop insurance are now a need and essential requirement.

The Area Yield Index Insurance (AYII) Model reasonably suits for the Punjab province in the given heterogeneous cropping pattern and inconsistent farm management and the same model can be implemented in other provinces of Pakistan by incorporating local requirements. However, this model can be further improved by reducing the basis risk associated with AYII model especially when average yield is computed for a larger geographical unit such as districts. This can be achieved by using remote sensing technology to periodically monitor the crop health and compute the crop yield for smaller geographic units such as tehsils or union councils. CRS Punjab is already working on these lines with technical support from Asian Development Bank (ADB).

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