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Research Article

Climate Change and Its Impact on Agriculture Productivity - A Case Study of Malwa Region, Punjab

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Abstract

Punjab's economy depends heavily on agriculture, which also contributes significantly to livelihood, food security, and national income. Climate Change refers to changes in all atmospheric conditions. There are two reasons for these climatic changes, which are very important, and they are natural changes and human activities. These two pose a severe threat to the environment as a result of which the environment is not able to maintain its quality and we have to live in a degraded environment. Currently, we are facing the same problem. Climate change is affecting the Malwa region, Punjab, with rising temperatures, changing precipitation patterns, and increased frequency of droughts and floods. This impacts agriculture, water resources, and livelihoods. Temperature increases by 1-2°C, and changed monsoon patterns threaten crop production and food security. Punjab is one of India's main agricultural hubs, and its agricultural output is greatly impacted by climate change. Reduced crop yields, changed growing seasons, and increased pest and disease pressure are some of the ways that climate change is affecting agricultural productivity. Warmer temperatures, altered precipitation patterns, and an increase in the frequency of extreme weather events all affect agricultural output. Agriculture productivity is directly dependent on climate change and weather. Crop growth is anticipated to be greatly impacted by potential changes in temperature, precipitation, and CO_2 concentration. Agricultural production is impacted by climate change, which results in lower crop yields, altered growing seasons, and more pest and disease pressure. Agricultural production is impacted by rising temperatures, changed precipitation patterns, and an increase in the frequency of extreme weather events. Agriculture productivity is directly dependent on climate change and weather. Crop growth is anticipated to be greatly impacted by potential changes in temperature, precipitation, and CO_2 concentration. Another important element influencing agricultural output in the Malwa region is temperature. Crop growing seasons and patterns are changing due to rising temperatures, which results in lower-quality and lower-yield food. Farmers in the area are finding it difficult to adjust to these changes, which has a big effect on their incomes. For instance, rising temperatures in recent years have resulted in a decrease in the yield of crops like cotton and wheat that are susceptible to changes in yield. This has impacted the region's food security in addition to the revenues of farmers. In conclusion, Punjab's Malwa region's agricultural productivity is being significantly impacted by climate change. To lessen the effects of climate change, it is imperative to address several important aspects, including drought, temperature, yield, irrigation, and sustainability. One of the most significant consequences of climate change is drought, which has had a profound impact on the region's agricultural industry. Although the Malwa region is renowned for its rich soil and temperate climate, agricultural production and farmers' livelihoods have been negatively impacted by the growing frequency and intensity of droughts.

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INTRODUCTION

Weather and climate change have a direct impact on agricultural productivity; potential changes in temperature, precipitation, and CO2 concentration are predicted to have a major effect on crop growth. The overall effect of climate change on the world's food production is estimated to be low to moderate with adequate irrigation and good adaptation. The global agricultural output might be increased if the CO2 fertilization impact doubles. Agriculture will be impacted by climate changes that impact water resources. Additionally, Punjab will see a stronger seasonal shift in temperature, with winter temperatures rising more than summer temperatures. Based on news articles from The Times of India that highlight Punjab's recurring drought situation, recent reports indicate that the state has experienced at least five droughts in the past 11 years, with some sources claiming that this is the fifth drought the state has faced during this period.

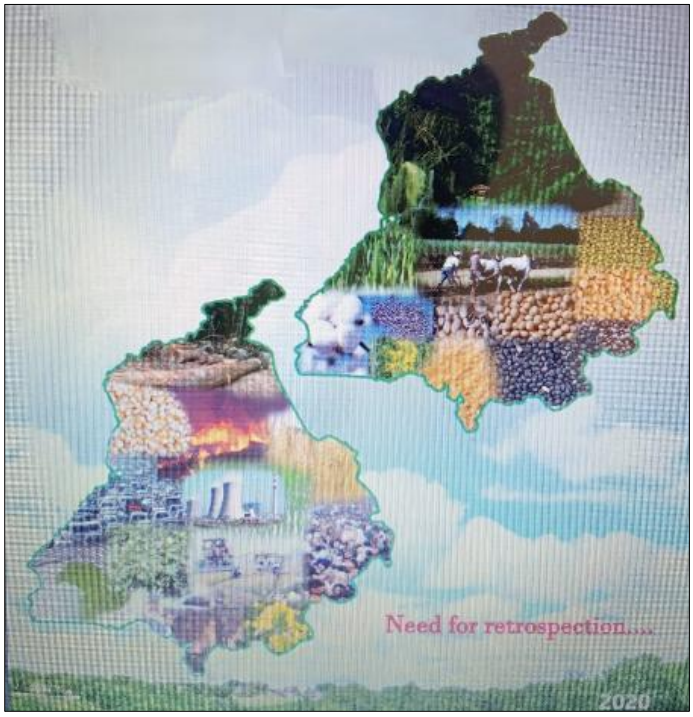
Extreme Weather Phenomena During Recent Years in Punjab

Table 1: Extreme Weather Events in Punjab (2011–2024)

Date	Extreme Events
6-7 January 2011	Snowfall in Pathankot
12 August 2011	400 mm of rainfall in 24 hours at Ludhiana
9 February 2012	The extremely low temperature of -0.4ºC at Bathinda
June 2012	No single rainy day at Ludhiana
June-July 2012	More rainfall at Bathinda as compared to Ludhiana
Year 2012	Prolonged winters (cold wave spell) as compared to previous years
December 2019	At Ludhiana monthly average of the maximum temperature was the lowest in last 22 years
Year 2019	At Ludhiana, rainfall during 2019 was 1156 mm against the normal of 752 mm. Since 1970, only 5 years had rainfall over 1150 mm
Year 2019	The lowest maximum temperature at Ludhiana since 1970 for six days (24-27 December and 29-30 December)
Year 2024	The average high temperature in Fazilka, Punjab in January is 64°F. The lowest temperature in Fazilka in January is usually around 46°F

	Gurdaspur		Ballowal Saunkhri		Ludhiana		Bathinda		Faridkot	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
December	0	9	1	8	0	16	2	15	7	16
January	12	10	7	3	3	10	15	12	8	14
Total	12	19	8	11	3	26	17	27	15	30

Citation: Climate Change in Punjab Facts. National Innovations on Climate Resilient Agriculture. Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana, and the Internet.



Climate Change in Punjab

Punjab and Climate Change. Indian Punjab is referred to as India's "food basket." Punjab has been supplying the central pool with 24-32 and 36-75 percent of rice and wheat, respectively, since 2005. When compared to other Indian states, it has a significant surplus of food grains. It is situated between latitudes 29°30' and 32°32' N and longitudes 73°55' and 76°50' E. Punjab is mostly a fertile plain. The location is between 180 and 500 meters above mean sea level. The terrain is semiarid and desert to the southeast, while a belt of rolling hills runs northeast near the base of the Himalayas. Punjab's climate ranges from semi-arid (southwestern) to sub-humid (north-eastern), with harsh winters and summers. With 31 million residents, Punjab accounts for roughly 2.3% of India's total population and 0.34% of the global population. About 63% of this population lives in rural areas and is mostly dependent on the agricultural sector. Given the significance of Punjab's agriculture for the country's food security, the livelihood security of the roughly 17 million people who depend on it, and its susceptibility to climate change, an attempt was made to record the variations in weather conditions that have taken place in the Indian state of Punjab.

Rainfall Distribution in Punjab

During the 2024 monsoon, Punjab State received 314.6 mm of rainfall, which was within the normal range according to the IMD classification, compared to its average of 439.8 mm with a departure of (-28%).

Figure 2: Displays the daily rainfall time series for Punjab during the 2024 monsoon season from June to September, along with cumulative and normal values. Up until the end of August, cumulative rainfall followed the usual pattern, but in September, there was a 28% overall deficiency in rainfall.

District Wise Rainfall Status

Out of the total 22 districts in Punjab, 04-districts have received normal rainfall, 1 district received excess, in rainfall in 17 districts was deficient in the state. District Tarn Taran received The highest rainfall (+48%) was observed while the district observed the least rainfall (-59%) during the district percentage departure of district-wise rainfall in Punjab from normal for the monsoon 2024 is shown in Figure 4 below.

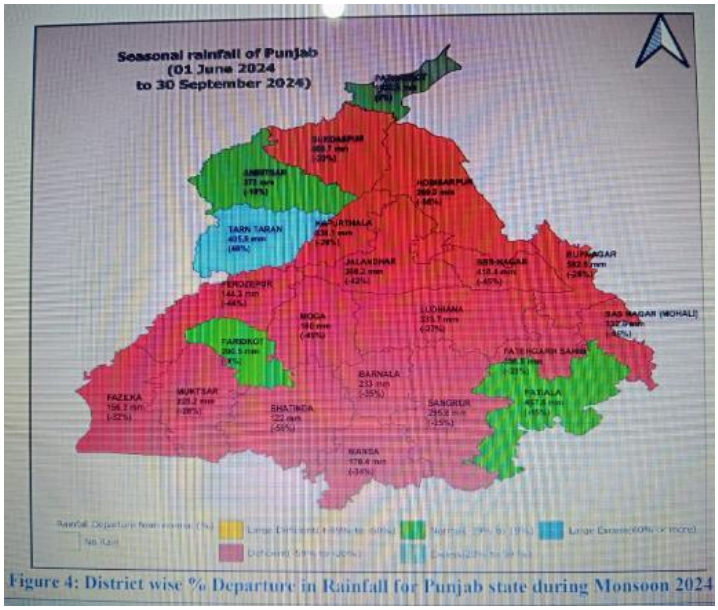


Figure 4: District wise % Departure in Rainfall for Punjab state during Monsoon 2024

Monsoon 2024 Rainfall			
Region	**Actual Rainfall (mm)**	**Long Period Average (mm)**	**% of LPA**
All India	934.8	868.6	108%
NW India	628.6	587.6	107%
Punjab	314.6	439.8	-28%

Source: South West Monsoon Season Report 2024, Punjab

Impacts of Climate Change on Agricultural Productivity

The economy, food security, and farmer livelihoods are all being impacted by the substantial impact that climate change is having on agricultural output. Numerous facets of agricultural output are affected by the wide-ranging effects of climate change on agricultural productivity.

Physical Impacts

1. Temperature Increase: As temperatures rise, the growing seasons change, agricultural yields decline, and crop quality is impacted.

2. Changing Precipitation Patterns: Droughts and floods are being caused by changes in rainfall patterns that impact the amount of water available for irrigation.

The total average annual rainfall in Punjab for a few selected years, expressed in millimeters, is shown in Table 2. It should be mentioned that the region's harvest years, which vary greatly in the twenty-first century, are expected to receive 700 mm of rainfall on average. The amount of rainfall in Punjab was 660.0 mm in 1970 and 650 mm in 1990, which was the highest average. However, the recorded rainfall amounts in 1990, 2000, and 2020 were 660.0 mm and 627.12 mm, respectively. With wintertime temperatures between 0°C and 47°C.Punjab has a predominantly subtropical climate. The rainy season, which lasts from June to September, accounts for 70–80% of precipitation.

Table 2: The average annual rainfall in Punjab (mm)

Years	Average annual rainfall (mm)
1970	660.0
1980	650.0
1990	660.0
2000	649.0
2010	472.1
2020	627.12

Source: Report of the Government of Punjab and the internet: Since 1970, 1980, 1990, 2000, 2010, 2020.

Table 3 explains, by decade, the average annual rainfall in the districts examined in the Malwa region. The table's data shows that the sampled districts' average annual rainfall range has significantly expanded. Sangrur and Bathinda districts experienced the highest level or the greatest variances between normal average rainfall and actual average rainfall, except Ludhiana and Patiala, which had less variation in average annual rainfall than the typical 7006mm. Despite significant differences, the average annual rainfall in these two districts has been 499.2 mm since 1970, 521.9 mm in 1970, and 455.6 mm in 2020. Ferozpur and Sangrur exhibit extreme fluctuation, with Firozpur experiencing an average annual rainfall of only 130.6 mm in 2000 and Sangrur experiencing an average annual rainfall of only 521.4 mm in 1980. Compared to 2000, the Mansa district experienced extremely little rainfall between 2010 and 2020. All things considered, Punjab's driest area with the lowest average yearly rainfall is the Malwa region.

Table 3: Decade-wise average annual rainfall (mm) in sample districts of Punjab

DISTRICT	1970	1980	1990	2000	2010	2020
Ludhiana	756.7	38.0	523.9	437.2	604.0	531.5
Firozpur	232.3	956.2	421.6	130.3	203.4	399.7
Bathinda	499.2	355.9	342.1	136.1	253.0	455.6
Sangrur	521.9	521.4	527.2	202.0	416.1	604.6
Mansa	-	-	-	208.3	120.6	224.4
Faridkot	-	511.4	567.8	256.5	459.0	667.1
Shri Muktsar Sahib	-	-	-	358.0	351.2	516.0
Patiala	555.6	835.7	662.7	641.2	483.7	678.2

Source: Statistical Abstract of Punjab: 1970, 1980, 1990, 2000, 2010, 2020.

Increased Frequency of Extreme Weather Events: Crop damage, yield reduction, and food security are being impacted by the frequent occurrence of heatwaves, droughts, and floods.
Soil Degradation: As a result of climate change, soil fertility and productivity are declining due to nitrogen depletion, salinization, and soil erosion.

Biological Impacts

Changes in Growing Seasons: Crop growing seasons are being impacted by variations in temperature and precipitation patterns, which result in lower yields and lower-quality produce.
Shifts in Pest and Disease Distribution: Crop yields are decreasing, and pest and disease pressure are increasing due to climate change.
Changes in Pollination Patterns: Climate change is affecting the pollination patterns of crops, leading to reduced yields and lower quality produce.

Economic Impacts

1. **Lower Crop Yields**: As a result of climate change, key crop yields are declining, which has an impact on food security and farmer livelihoods.
2. **Rising Costs:** The profitability of farming and farmers' lives are being impacted by the rising costs of agricultural production brought on by climate change.
3. **Income Loss:** Farmers are experiencing income loss as a result of climate change, which limits their capacity to make investments in their farms and raise their standard of living.
4. **Food Price Volatility:** As a result of climate change, food prices are becoming more volatile, which impacts disadvantaged groups' ability to obtain food.

Social Impacts

1. **Migration and Displacement**: Rural communities are experiencing migration and displacement as a result of

climate change, which has an impact on their well-being and means of subsistence.
2. **Rural Poverty:** The livelihoods and general well-being of rural communities are being negatively impacted by climate change, which is making rural poverty worse.
3. **Food Insecurity:** As a result of climate change, there is less food available and accessible, especially for disadvantaged groups.
4. **Human Health:** Heat stress, water-borne illnesses, and other climate-related health effects are increasing morbidity and death as a result of climate change.

Strategies for Adaptation and Mitigation

1. Climate-Smart Agriculture: Putting into practice climate-smart agricultural techniques, like agroforestry, conservation agriculture, and climate-resilient crop and animal breeds. **2. Irrigation Management:** Enhancing irrigation management through the implementation of effective irrigation systems and water-saving technology. **3. Soil Conservation:** Putting soil conservation techniques like cover crops, terracing, and contour farming into practice. **4. Climate Information and Early Warning Systems:** Farmers should have access to early warning systems and climate information to help them make informed decisions and adapt to climate change.

All things considered, climate change has a substantial impact on agricultural productivity, and mitigation and adaptation to these changes call for quick attention and action.

CONCLUSION

The phenomenon of climate change is not new. Changes in crop productivity and the quantity and quality of water resources are two of the major effects of climate change, which 8presents numerous risks. The Indian subcontinent is extremely vulnerable to climate change, it can be inferred.

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