

IMPACT OF - CLIMATE CHANGE ON CROP YIELD

© 2025

Corresponding author: neelak-
shisharma20@gmail.com

MOHIT KASHYAP¹

Ankit Saini²

Neelakshi Sharma¹

Chinmaya Sahoo³

1. Ph.D. Research Scholar,
Department of Soil Sci-
ence, CSK HPKV, Palam-
pur, HP, India-176062
2. Dr. KSG Akal College of Ag-
riculture, Eternal Univer-
sity, Baru Sahib, Sirmaur,
Himachal Pradesh, India
3. Dr. Rajendra Prasad Cen-
tral Agricultural Univer-
sity, Pusa, Bihar, India

**Volume 01 - Issue 05 || November
2025**

WWW.DIGITALAGRI NEWS.COM



ORGANIC FARMING - AND ITS AGRONOMIC IM- PORTANCE

Abstract

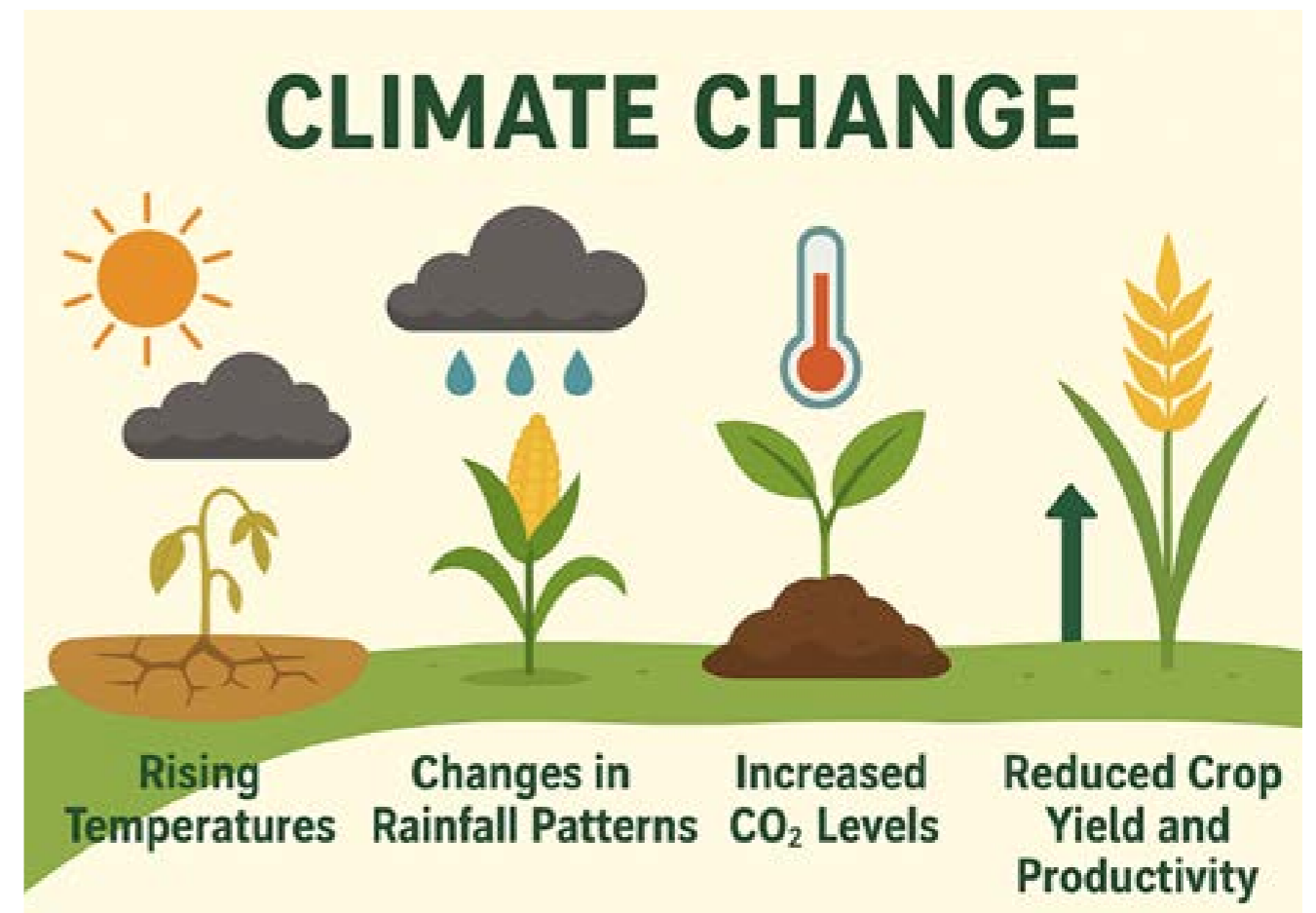
Climate change has emerged as one of the most significant global challenges affecting agricultural productivity, food systems, and socio-economic stability. Its impacts on crop yields are influenced by rising temperatures, erratic rainfall, increased atmospheric CO₂ concentrations, frequent extreme weather events, soil degradation, and changing pest and disease dynamics. This article provides a comprehensive analysis of the biophysical and socio-economic effects of climate change on crop yield, supported by scientific evidence from global studies. It highlights crop-specific impacts, regional variations, and the increasing vulnerabilities of smallholder farmers. Additionally, the article discusses adaptation and mitigation strategies such as climate-resilient crop varieties, advanced irrigation techniques, sustainable land management, and policy interventions. This emphasizes the urgency of integrated approaches to safeguard global food security under rapidly changing climatic conditions.

Keywords: *Climate change, crop yield, extreme weather, food security, and adaptation strategies.*

Introduction

Climate change has become a central global concern due to its far-reaching effects on natural ecosystems, economic sectors, and human livelihoods. Agriculture, being highly dependent on climatic factors such as temperature, rainfall, humidity, and solar radiation, is exceptionally vulnerable to climate variability. Over the last few decades, climate-related disruptions have increasingly influenced the growth patterns, productivity, and distribution of major agricultural crops. The Intergovernmental Panel on Climate Change (IPCC, 2014, 2022) reported that global temperatures have increased by over 1.1°C since the pre-industrial era, and this warming trend is projected to intensify. Such climatic changes are particularly concerning because they directly affect crop physiology, soil health, water availability, and pest dynamics (Challiner et al., 2014).

Global population growth, estimated to reach 9.7 billion by 2050, increases the demand for food, placing additional pressure on agricultural systems already strained by climate impacts (FAO, 2018). Developing nations, especially those with large populations relying on small-scale and rainfed farming, face the greatest risks. Therefore, understanding how climate change alters crop yields is essential for designing effective adaptation and mitigation strategies. This article aims to explore these impacts comprehensively while highlighting policy and technological interventions critical for future resilience.



Impact of Climate Change on Crop Yield

1. Effects of Rising Temperatures

Temperature influences nearly every aspect of crop development. A moderate increase may benefit crops in cooler climates; however, most agricultural regions experience negative impacts as temperatures exceed optimal ranges. High temperatures accelerate plant respiration, reduce photosynthetic efficiency, and cause heat stress, especially during reproduction. For example, rice and wheat suffer reduced grain filling when exposed to temperatures above 35°C. Maize yields decline sharply under prolonged heat, and crops such as potato and soybean experience physiological disruptions. Heat stress also increases evapotranspiration, leading to rapid soil moisture

depletion and increased irrigation demands (Porter & Semenov 2005).

2. Changing Rainfall Patterns and Water Scarcity

One of the most visible consequences of climate change is the shift in rainfall patterns. Increased frequency of droughts affects crop germination, nutrient uptake, and biomass accumulation. Rainfed agriculture, which supports nearly 60% of global crop production, is particularly affected. In contrast, excessive rainfall leads to waterlogging, delayed planting, root suffocation, soil erosion, and nutrient leaching. Monsoon variability in Asia and Africa has resulted in unpredictable growing seasons, causing repeated crop failures. Groundwater

depletion further intensifies water stress in regions with high irrigation demands.

3. Extreme Weather Events

Climate change increases the frequency and intensity of extreme weather events such as cyclones, floods, droughts, storms, heatwaves, and cold spells. These events cause extensive agricultural losses, destroy standing crops, damage infrastructure, and disrupt supply chains. Heatwaves can cause sudden crop wilting and sterility, while floods can wash away fields and degrade soil structure. Cyclones severely impact coastal agriculture, affecting crops such as rice, coconut, and bananas. Such events leave long-term effects, reducing productivity for several seasons (Porter et al., 2005).

4. Elevated CO₂ Concentration and Crop Physiology

Elevated CO₂ levels may initially stimulate plant growth through enhanced photosynthesis, especially in C3 crops like rice, wheat, and legumes. However, this CO₂ fertilization effect is limited and often offset by negative interactions with temperature stress, nutrient limitations, and reduced water availability. Furthermore, elevated CO₂ reduces protein content and micronutrient density in grains, directly affecting food quality. Higher CO₂ also accelerates weed growth, increasing competition for nutrients and water (Mader et al., 2022).

5. Increased Pest, Disease, and Weed Pressure

Climate change disrupts temperatures ecosystems and creates favourable conditions for pest and disease proliferation. Warmer allow insects to reproduce faster and expand into new regions. Diseases such as bacterial blight, rust, and powdery mildew become more prevalent under warm and humid conditions. Weeds, being inherent-

ly resilient, benefit the most from elevated CO₂, challenging crop productivity. Increased pest pressure also drives up pesticide use, contributing to environmental degradation (Lobell et al., 2011).

6. Soil Degradation and Nutrient Loss

Soil health underpins agricultural productivity, and climate change contributes to its degradation through erosion, salinization, acidification, and nutrient depletion. Heavy rainfall causes topsoil loss, while drought reduces organic matter and microbial activity. Sea-level rise leads to soil salinity in coastal farmlands, reducing the productivity of crops like rice, vegetables, and fruits. Nutrient imbalances caused by leaching or volatilization hinder crop growth and reduce yield stability.

7. Regional Impacts and Crop-Specific Responses

Climate change does not affect all regions or crops equally. Tropical and subtropical regions experience the most severe impacts due to already high baseline temperatures. Crops like wheat and maize show sharp yield declines in South Asia and Africa, while temperate regions may initially experience some benefits. Cash crops such as cotton, coffee, tea, and sugarcane also respond uniquely, with shifts in suitable growing zones. Regional food security risks rise as climate impacts intensify.

8. Socio-Economic Implications for Farming Communities

Climate change affects not only crop yields but also the economic stability of farming households. Yield losses lead to income reduction, increased debts,

and food insecurity. Smallholder farmers with limited access to irrigation, credit, and technology are the most vulnerable. Climate-induced migration, market disruptions, and price volatility further threaten rural livelihoods (Wheeler & Von. 2013).

Adaptation and Mitigation Strategies

Climate-smart agriculture provides a pathway to strengthen resilience. Key adaptation strategies include developing drought- and heat-tolerant varieties, improving irrigation efficiency, adopting conservation tillage, diversifying cropping systems, and implementing precision agriculture. Agroforestry, integrated pest management, and soil conservation techniques help sustain long-term productivity. Mitigation strategies include reducing greenhouse gas emissions from agriculture, improving nitrogen-use efficiency, and enhancing soil carbon sequestration (Tonitto et al., 2006).

Research and technological priorities

- Better process-based crop models that capture heat × drought × CO₂ interactions.
- Locally tailored breeding programs for climate resilience.
- Socioeconomic research on adoption barriers for adaptation measures.
- Improved monitoring of pests/diseases and early-warning systems.
- Cross-scale assessments linking field experiments, regional models and socioeconomic scenarios.

Policy and institutional measures

Policies must combine mitigation (to limit future warming) with adaptation support: investment in climate-smart infrastructure, extension services to scale resilient practices, markets and insurance schemes to buffer shocks, and international cooperation to support vulnerable countries. Major assessment reports stress the need for integrated food-climate policy and targeted finance.

Conclusion

Climate change presents a multifaceted challenge to global agriculture, with profound implications for crop yield, food security, and socio-economic development. The combined effects of rising temperatures, altered rainfall patterns, extreme weather, shifting pest dynamics, and soil degradation threaten the stability of food production systems. While elevated CO₂ may offer temporary benefits, long-term projections indicate substantial yield reductions for major staple crops. To safeguard future food systems, nations must prioritize sustainable agricultural practices, invest in climate-resilient technologies, strengthen policy frameworks, and enhance farmer capacity. Ultimately, addressing climate change requires collective global action.

References

- Challinor, A. J., Watson, J., Lobell, D. B., Howden, S. M., Smith, D. R., & Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation.

Nature Climate Change, 4, 287–291.

- FAO. (2018). *The State of Food Security and Nutrition in the World 2018*. Food and Agriculture Organization of the United Nations (SOFI Report).
- IPCC. (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Fifth Assessment Report of the IPCC. Cambridge University Press / IPCC.
- IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the IPCC. Cambridge University Press / IPCC.
- Lobell, D. B., Schlenker, W., & Costa-Roberts, J. (2011). Climate trends and global crop production since 1980. *Science*, 333(6042), 616–620.
- Mader, P., Fliebbach, A., Dubois, D., Gunst, L., Fried, P., & Niggli, U. (2002). Soil fertility and biodiversity in organic farming. *Science*, 296(5573), 1694–1697. (*Long-term trial evidence on soil and productivity trends*.)
- Porter, J. R., & Semenov, M. A. (2005). Crop responses to climatic variation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360(1463), 2021–2035.
- Tonitto, C., David, M. B., & Drinkwater, L. E. (2006). Replacing bare fallows with cover crops in fertilizer-intensive cropping systems: A meta-analysis. *Agronomy Journal*, 98(3), 599–620. (*Useful for resilience and soil-health co-benefits of cover crops*.)
- Wheeler, T., & Von Braun, J. (2013). Climate change impacts on global food security. *Science*, 341(6145), 508–513.