



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; SP-9(4): 238-242
Received: 26-01-2026
Accepted: 28-02-2026

Mamta Phogat
Krishi Vigyan Kendra, Bhiwani,
CCS Haryana Agricultural
University, Hisar, Haryana, India

Murari Lal
Krishi Vigyan Kendra, Bhiwani,
CCS Haryana Agricultural
University, Hisar, Haryana, India

RS Dhillon
Krishi Vigyan Kendra, Bhiwani,
CCS Haryana Agricultural
University, Hisar, Haryana, India

Meenu
Krishi Vigyan Kendra, Bhiwani,
CCS Haryana Agricultural
University, Hisar, Haryana, India

Sunil Kumar
M.Sc. Soil Science, CCS Haryana
Agricultural University, Hisar,
Haryana, India

Global impact of climate change on agriculture

Mamta Phogat, Murari Lal, RS Dhillon, Meenu and Sunil Kumar

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i4Sc.5404>

Abstract

Climate change is already reshaping agriculture worldwide, with rising temperatures, erratic rainfall, and extreme weather events threatening crop yields, food security, and farmer livelihoods. In India, where agriculture supports nearly half the population, these impacts are particularly severe, requiring urgent adaptation strategies. Over periods ranging from decades to millions of years, aberrant alterations to the predicted climate within the Earth's atmosphere and the ensuing impacts on other regions of the planet, including the ice caps, are reflected in climate change. Any long-term, substantial shift in the typical weather patterns of a particular area over a suitably long period of time is referred to as climate change. Climate change poses significant risks to agriculture by reducing crop yields, degrading soil, and increasing water scarcity, but adaptation strategies such as climate-smart agriculture and resilient farming practices can mitigate these impacts. The agricultural sector alone accounts for 23% of India's GDP, is vital to the nation's development, and will always play a significant role in the country's economy. Almost 70% of the people depends on it for their living. Any major global climate change will undoubtedly have an influence on regional agriculture and, consequently, the world's food supply. Through their direct and indirect effects on crops, soils, livestock, and pests, global climate change can have an impact on agriculture. Climate change is altering temperature patterns, rainfall distribution, and increasing the frequency of extreme weather events. Agriculture, being highly dependent on natural resources, is one of the most vulnerable sectors. Climate change is both a challenge and an opportunity for agriculture. While it threatens productivity and sustainability, it also drives innovation in farming practices. Adopting climate-smart agriculture and strengthening resilience policies are essential to safeguard food security worldwide.

Keywords: Climate change, agriculture, food security, global warming, sustainability

Introduction

Since the beginning of Earth's existence 45 billion years ago, the climate has changed naturally at its own rate; yet, due to unintentional human disruptions, it has recently acquired momentum. These alterations could have a negative effect on both human health and the environment, which is essential to our survival. The complex interactions between people and the concentration of greenhouse gases (GHGs), such as CO₂, CH₄, and N₂O, cause global warming and other cascading effects, such as changes in rainfall patterns, glacier melting, sea level rise, etc. The aforementioned complex relationships between atmospheric composition, climate change, and the health of people, plants, and animals must be examined, and potential remedies to the unfavorable changes may be looked for. According to the World Meteorological Organization, Climate is the aggregate of weather condition over a long period of time, the classical period is 30 years.

Climate Change: Climate change is any long-term significant change in the expected patterns of average weather of a specific region over an appropriately significant period of time.

Climate Variability: The way the climate varies annually above or below a long-term average value is known as climate variability.

Climate Vulnerability: The degree to which a system is vulnerable to or incapable of handling the negative consequences of climate change, such as climate extremes and variability, is known as vulnerability.

Corresponding Author:
Mamta Phogat
Krishi Vigyan Kendra, Bhiwani,
CCS Haryana Agricultural
University, Hisar, Haryana, India

Causes of Climate Change

(a) Natural Processes

Variation in Earth's Orbital Character

The Earth's orbit around the Sun is shaped by the first cyclical fluctuation, called eccentricity. Over the course of around 100,000 years, the orbit gradually shifts from being elliptical to almost circular and back again. The difference in solar energy received at the top of the atmosphere between Earth's closest (perihelion) and furthest (aphelion) approaches to the Sun increases with orbital eccentricity, or how elliptical the orbit is. The quantity of solar radiation received at the top of the atmosphere varies by around 7% due to the difference in Earth's distance from the Sun between perihelion and aphelion, which is only about 3%. The difference in solar energy received is approximately 20% when this distance is at its highest (9%).

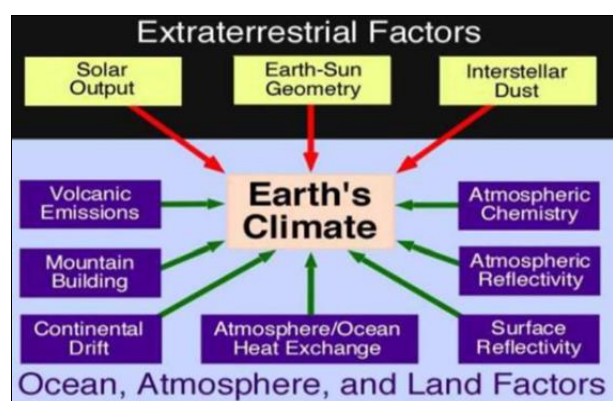


Fig 1: Factors affecting earth's climate

Volcanic Eruptions

Large, explosive volcanic eruptions have been linked to short-term climate change, according to climatologists. There have been two major eruptions that have altered the climate in the past century. In April 1982, El Chichon erupted in Mexico, and in June 1991, Mount Pinatubo erupted in the Philippines. Of these two volcanic eruptions, Mount Pinatubo released over 20 million tons of SO₂ into the stratosphere and had a bigger impact on Earth's climate. The Pinatubo explosion was thought to be the main cause of the 1992 global average air temperature drop of 0.8 degrees Celsius.

According to satellite data, the eruption's sulfur dioxide plume increased the amount of sunlight reflected back into space by the Earth's atmosphere by several percent, causing the planet's surface to cool.

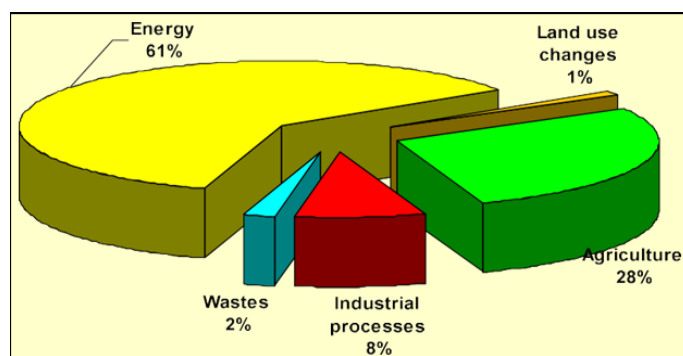
Variation in Solar Output

In just eighteen months, measurements taken by radiometer-equipped satellites in the 1980s and 1990s revealed a 0.1 percent drop in the overall quantity of solar energy reaching Earth. The global climate might be impacted if this tendency continued for several decades. For a long time, scientists have also attempted to connect sunspots to climate change. Large magnetic storms known as sunspots appear as colder, black patches on the Sun's surface. Sunspot size and quantity exhibit cyclical patterns, peaking roughly every 11, 90, and 180 years. According to the 11-year cycle, the early 1980s solar energy decline coincides with a time of peak sunspot activity.

a) Anthropogenic Causes

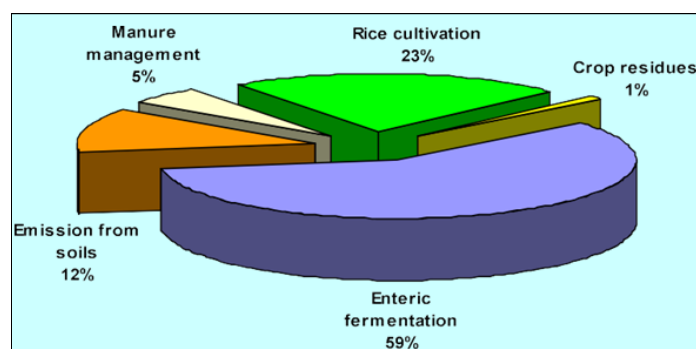
The amount of sunlight reflected back into space (the surface albedo) has changed as a result of changes in land use, such as the clearing of forests to make way for farms. These fluctuations

are thought to account for roughly one-fifth of the global climate forcing caused by variations in greenhouse gas emissions. An estimated half of the changes in land use are thought to have happened during the industrial era, primarily as a result of agricultural cropping and grazing fields replacing forests.



Source: NATCOM-2004

Fig 2: Contribution of different sectors in India to climate change (Sources of greenhouse gas emission in India)



Source: NATCOM-2004

Fig 3: Contribution of agriculture in India to climate change,

Greenhouse Gases Carbon Dioxide (CO₂)

With a contribution of 63.54% to the total global radiative forcing, carbon dioxide is the most significant anthropogenic greenhouse gas in the atmosphere. Burning wood and wood products, fossil fuels (coal, oil, and natural gas), and solid waste releases carbon dioxide into the atmosphere.

About 50% percentage of carbon dioxide that is emitted into the atmosphere is absorbed by the ocean. Because it can reabsorb long wave radiation from the Earth's surface, it can change the planet's energy balance. Because it affects root and soil respiration, temperature has a significant impact on the evolution of CO₂ from soil. It should be noted that the main carbon dioxide sinks are plants, oceans, and atmospheric processes.

Methane (CH₄): It is twenty fold more effective as a heat-trapping gas than CO₂. It is a product of incomplete decomposition caused by a group of bacteria called Methanogens, under anaerobic condition. The main sources of methane are: wetlands, organic decay, termites, natural gas and oil extraction, biomass burning, rice cultivation, cattle and refuse landfills. Agriculture contributes 68% to it. 18.1% of the total radiative force in the world comes from methane. Methane is released when coal, natural gas, and oil are produced and transported. It is also released when organic materials break down.

Nitrous Oxide (N₂O): Nitrous oxide is 298-times more effective than CO₂. The main sources include burning fossil

fuels and organic materials, applying fertilizer and manure, and cultivating land. It depletes the ozone layer. It makes up 6.24% of the total radiative forcing in the world. It is released during industrial and agricultural processes, as well as when fossil fuels and solid waste are burned.

Water Vapour: More thermal infrared radiation from the Earth can be absorbed by it, warming the atmosphere even more. More water vapor can then be stored in the warmer atmosphere.

Fluorinated Gas: Sulfur hexafluoride (SF₆), perfluorocarbon (PFC), and hydro fluorocarbons (HFC) are potent greenhouse gases produced by a range of industrial activities. Twelve percent of the total global radiative forcing comes from fluorinated gases.

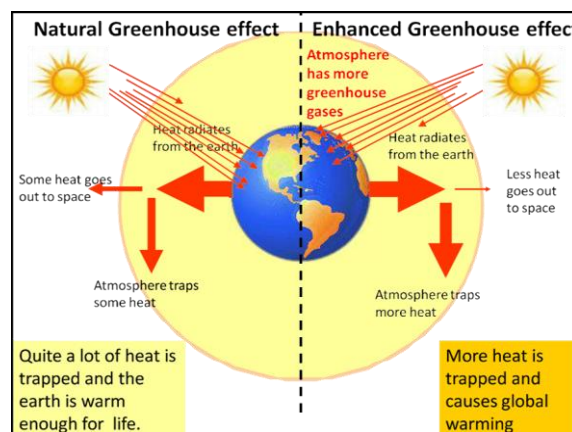


Fig 4: Greenhouse Effect

Table 1: Greenhouse gases and their contribution

Greenhouse Gases	Greenhouse Effect%	Natural%	Man-Made%
Water vapour	95.000	94.999	0.001
Carbon Dioxide	3.618	3.502	0.117
Methane	0.360	0.294	0.066
Nitrous Oxide	0.950	0.903	0.047
Misc. Gases	0.072	0.025	0.047
Total	100	99.72	0.28

Source: Babu *et al*, 2014

Table 2: 20th century changes in the earth's atmosphere

Indicator	Observed Change
Atmospheric concentration of CO ₂	280 ppm for the period 1750 to 379 ppm in 2005 (35% increase)
Atmospheric concentration of CH ₄	715 ppb for the period 1750 to 1,774 ppb in 2005 (148% increase)
Atmospheric concentration of N ₂ O	270 ppb for the period 1750 to 319 ppb in 2005 (18% increase)
Tropospheric concentration of O ₃	Increased by 35% from the year 1750 to 2000, varies with region
Stratospheric concentration of O ₃	Decreased over the year 1970 to 2000, varies with altitude and latitude
Atmospheric concentration of HFCs, PFCs	Increased globally over the last 50 years

Source: IPCC, 2007

Climate Change and Indian Agriculture

Agriculture sector alone represents 23% of India's Gross National Product (GNP), plays a crucial role in the country's development and shall continue to occupy an important place in the national economy. It sustains the livelihood of nearly 70% of the population. It seems obvious that any significant change in climate on a global scale will impact local agriculture and therefore affect the world's food supply. Global climatic changes can affect agriculture through their direct and indirect effects on the crops, soils, livestock and pests.

Impact of Climate Change to Agriculture

1. Impact on Crop Growth Parameters and Yield

CO₂ content continues to rise, most plants will exhibit increased rates of photosynthesis and biomass production. Consequently, this phenomenon should enhance the amount of food, fiber and timber products population. However, some individuals have predicted that the growth-promoting effects of atmospheric CO₂ enrichment may be negated by global warming, which could compromise our ability to sustain greater human populations without increasing arable land acreage. We thus turn to the scientific literature to see if plants will continue to exhibit CO₂-induced growth increases under conditions of elevated air temperature.

A) Photosynthesis

In C₃ plants, Rubisco is not saturated by the current

concentration of CO₂ in the atmosphere. So an increase in its concentration will improve the balance of CO₂ and O₂ at Rubisco site, thus improving the CO₂-Exchange Rate (CER) of the plant by providing more substrate for photosynthesis (Carbon dioxide fertilization) Prasad *et al.* (2003) reported that doubling of ambient CO₂ concentration (350 vs. 700 $\mu\text{mol mol}^{-1}$) enhanced leaf photosynthesis of groundnut by 27% across a range of day-time temperatures (32 to 44 °C).

B) Water Relations

a) Stomatal Conductance

Elevated CO₂ causes partial stomatal closure, which reduces the stomatal conductance for the exchange of gases between the internal tissues of plant leaves and the atmosphere approximately by 10% both in C₃ and C₄ plants (IPCC, 2007). This will increase the stomatal resistance leading to reduced evapotranspiration by 0.9% (Kimball, 2007).

b) Canopy Temperature

Elevated CO₂ reduces stomatal conductance, transpirational cooling of the plant leaves is also reduced causing leaf temperature to rise. Hence, rise in canopy temperature.

c) Evaporation or Water Use

With rise in canopy temp., the vapour pressure inside the leaves raises, which tend to increase the leaf transpiration negating some of the reduction due to reduced stomatal conductance.

A Simulation Study in Punjab by Kaur (2010) [4] Shows That

- Increase in temp. by 1-2 °C reduced grain yield in wheat by 9.8- 18.4%, in rice by 2.8 to 9.6% and by 10.4 to 14.6% from normal in maize;
- Increased in CO₂ showed counteracting effect on increasing temperature in yield reduction to more extent in wheat (where grain yield increased by 5.6%) as compared to maize (increased by only 2.8%).

Studies in Bundhelkhand Region Shows

- Rainfall shows declining trend and shifting of precipitation by over a month.
- The shift causes delay in sowing, in turns delay harvesting and consequently reduce yield.

Temperature increases of 1 °C, 2 °C, and 3 °C would reduce rice grain yield by 5.4%, 7.4%, and 25.1%, respectively, if all other climatic conditions were same, according to studies on the effects of climate change on rice productivity in Punjab, India.

2. Impact on Weed, Pest and Diseases

- Enhanced CO₂ concentration and increased temp. Benefitted the weed creating potential for increased competition: *Amaranthusretroflexus* produced more seeds under barley cropping.
- C3weeds shows substantial resistance to applied herbicides at elevated CO₂.
- Change in weed ecology: weedy rice may become a more problematic weed in the future in India due to climate change (Chauhan *et al.*, 2014) [6].
- Damage- niche concept by Donald (2009) refer to the suite of factors under which specific weed species are judged troublesome to the production of specific crops.

3. Impact on Crop Quality

- In maize, the protein content of the grain decreases under combined increases of temperature and CO₂.
- For rice, the amylase content of the grain-a major determinant of cooking quality-is increased under elevated CO₂.
- With wheat, elevated CO₂ reduces the protein content of grain and flour by 9-13%. Concentrations of Fe and Zn which are important for human nutrition would be lower (Senapati *et al.* 2013).
- Erbs *et al.*, 2010, observed that increasing CO₂ conc. to 550 ppm with two rates of N fertilization (adequate and half) reduces crude protein by 4-13% in wheat and 11-13% in barley but increased starch by 4% when N half rate.

4. Impact on Soil Productivity

- The residues of crops under the elevated CO₂ concentrations will have higher C: N ratio, and this may reduce their rate of decomposition and nutrient supply.
- Rise in soil temperature will increase N mineralization, but its availability may decrease due to increased gaseous losses through volatilization and denitrification.
- Change in rainfall volume and frequency, and wind may alter the severity, frequency and extent of soil erosion.
- Rise in sea level may lead to salt-water ingress in the coastal lands, turning them less suitable for conventional agriculture.

5. Impact on Cropping System

- Studies in Bundhelkhand region shows that sorghum area is

decreasing due to uncertainty, erratic and low rainfall for more than 5 years. The area is now shifted to black gram/greengram and sesame in kharif season

- The rainfall shows declining trend and shifting of precipitation by over a month. The shift causes delay in sowing.

6. Impact on Water Availability

- Demand for irrigation water would increase with rise in temperature and evapo-transpiration rate.
- Significant increase in runoff is projected in the wet season.
- This additional water in the wet season, on the other hand, may lead to increase in frequency and duration of floods.
- The water balance in different parts of India will be disturbed.
- The quality of groundwater along the coastal track will be affected more due to intrusion of sea waters.

7. Impact on Livestock and Fishery

- Affect fodder production and nutritional security.
- Increased temp. Enhanced lignification of plant tissues, reducing the digestibility.
- Increased water scarcity would also decrease production of feed and fodder.
- Major impacts on vector-borne diseases will be through expansion of vector populations in the cooler areas. Changes in rainfall pattern may also influence expansion of vectors during wetter years, leading to large outbreaks of diseases.
- Climate change is likely to aggravate the heat stress in dairy animals, adversely affecting their reproductive performance. Heat stress will reduce milk production by 10-25%

Adaptation Strategies to Climate Change

- Developing Climate-ready Crops: ex *Sorghum bicolor* L. Moench cv. SPV462 to enhance tolerance to water deficit and NaCl stresses (Maheswari *et al.* 2006)
- Germplasm exploration of all land varieties, wild varieties that might have be of some use to us in the future.
- Improved and novel agronomic and crop production like adjusting date of planting, crop rotation, intercropping, Promotion of agroforestry etc.
- Crop Diversification and livestock varieties like replacement of plant types, cultivars, hybrids, and animal breeds with new varieties intended to perform better under stress situation
- Efficient Use of Resources: *in-situ* moisture conservation, rain water harvesting and recycling, efficient use of irrigation water, conservation agriculture, energy efficient agriculture, use of poor quality water as well as, INM & SSNM

Mitigation Strategies to Climate Change Reduction of Methane Emission

- In rice the practice of mid-season drainage instead of continuous flooding;
- Direct crop establishment like DSR.
- Use of narrow C: N ratio organic manure and biogas slurry.
- In ruminant altering the feed composition either to reduce the percentage of matter that is converted to methane.

Reduction Nitrous Oxide

- Application of nitrate N-fertilizer like CAN in aerobic

conditions

- Ammonium Fertilizer like Ammonium Sulphate, Urea in wet land crops
- Use of Nitrification inhibitors for reducing Nitrification.

CO₂ Emission

CO₂ emission from agriculture can be reduced by increasing Carbon sequestration in soil through:

- Manipulation of soil moisture and temperature;
- Soil management practices such as reduce tillage and manuring, residue incorporation, improving soil biodiversity and mulching.

Efficient Use of Resources

RCTs encompass practices include *in-situ* moisture conservation, rain water harvesting and recycling, efficient use of irrigation water, conservation agriculture, energy efficient agriculture, use of poor quality water as well as ZT, SRI, INM & SSNM.

Residue Retention Instead of Burning Reduces GHG Emission

Residue retention at the field can be used a mulch which helps in moisture retention as well as prevents soil erosion. It also increases organic matter content of soil when incorporated. Burning of 1 Mg rice straw emits CO₂-C: 280 kg, CH₄-C: 3 kg, N₂O-N: 0.07 kgGWP: 1118 kg CO₂ equiv.



One of the preliminary understandings of residue incorporation and retention in rice –wheat cropping system can mitigate global warming. A 1118 kg gas of CO₂ equivalent produces as well as 10-15 kg of NPK is lost from the soil which can be easily incorporated in soil by adopting these CA based RCTs. C-sequestration is the additional advantage in residues incorporation.

Burning of crop residue releases the GHG in the atmosphere. Emissions of GHGs was determined on basis of product of emission factors and crop residues burnt (Based on IPCC Coefficient). The quantity of GHGs (CO₂, CH₄, N₂O) emitted by crop residue burning from Madhya Pradesh itself is about 5676.46 kg/year. In which contribution of CO₂; CH₄ and N₂O is about 5666.1 kg/year, CH₄ is about 10.10 kg/year and about 0.26 kg/year respectively. Critical analysis of table-3 indicates that, carbon dioxide is the most dominant among three gases.

Table 3: Emission of greenhouse gases from crop residue burning

Name of the Gas	Emission
CO ₂ kg/year	5666.1
CH ₄ kg/year	10.10
N ₂ O kg/year	0.26
Grand total	5676.46

Conclusion

- Increased CO₂ will facilitate fertilization effect.
- Increased temperature increase the production in temperate region whereas decrease in tropical countries.

- Irregular precipitation pattern leads to flood or drought causing shift in cropping system.
- Loss of soil productivity and scarcity of irrigation water impacted agriculture production.
- Adaption and Mitigation strategies are to be adopted based on the prevailing situation for sustained supply of food for the growing population.

References

1. Sharmila K, Ramya S, Babu Ponnusami A. Carbon sequestration using microalgae: a review. International Journal of Chem Tech Research. 2014;6(9):4128-4133.
2. Agarwal PK. Climate change: implications for Indian agriculture. Jalvigyan Samakshya. 2007;22:1-22.
3. Hatfield JL. Climate impacts on agriculture: implications on crop production. Agronomy Journal. 2011;103(2).
4. Kaur P. Effect of climate change on agriculture. In: Walia SS, Gosal SS, editors. Contingent crop planning. 2011:8-32.
5. Prajapati RK, Singh SR, Gangwar RK. Effect of climate change on plant disease in Bundelkhand zone leading to change in cropping system. Agriways. 2015;3(2):120-138.
6. Chauhan BS, Ramesh K. Weed regimes in agro-ecosystems in the changing climate scenario: a review. Indian Journal of Agronomy. 2005;60(4):479-484.