



## EFFECTS OF CLIMATE CHANGE ON AGRICULTURAL CROPS AND BIODIVERSITY: A REVIEW

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**Abstract:** Global climate has slowly changed and evolved over the millions of years and has acquired the present-day characteristics. During the past few decades there has been a rise of average temperatures due to excessive emission of green-house gases in the atmosphere by anthropogenic activities. Rainfall patterns also got affected by change in temperature via evapotranspiration and wind velocity. Rise in the temperature is also responsible for loss of biodiversity with an increase in population of pests and pathogens that created a severe problem for the good health and survival of the entire biota. Global climate change is the biggest disaster in the history of human beings that increased the waterborne as well as vector borne diseases like Covid-19 i.e. Corona pandemic. As a consequence, scientists across the world have started to focus on reducing crop production loss and to establish sustainable development. This review gives an assessment of the impact of climate change on agricultural crops, food security and biodiversity.

**Keywords:** Anthropogenic activities, Biodiversity loss, Climate change, Crops, Food security.

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### INTRODUCTION

Due to rapid industrialization and urbanization, it has been recognised worldwide that tremendous alteration in the composition of the atmosphere is likely to alter the earth's climate which has severe implications on the vegetation. It has been found that the global average parameters are now changing mainly due to greenhouse effect, excess of carbon dioxide concentration, nitrous oxide, methane and chlorofluorocarbons discharged by human beings in various forms across the world. It has caused severe damage to the ground vegetation as well as the aquatic ecosystem. The rise in carbon dioxide concentration during the past decade

global climate change has become a major issue (Friend *et al.*, 2014). Climate change impacts on vegetation dynamics have influenced the global terrestrial as well as aquatic ecosystem adversely, causing alteration in the ecosystem (Wu *et al.*, 2015; Xu *et al.*, 2020; Prakash, 2021). Climate change has altered biodiversity, agricultural productivity, food security and sustainable development (Verma, 2021). This is the biggest environmental problem faced and caused by humans and other forms of life unless it is tackled on a world wide scale (Kotir, 2011).

The last century experienced a strongest warming trend with rising average temperatures by about



0.5 to 0.6° C (Dawson *et al.*, 2016). This suggests that if the same trend of rise in temperature persists then next decade will be warmer. The threat of varying global climate change like increased frequency of flood, rainfall, drought and fluctuation in the temperature, out-break of pests has greatly driven the attention of environmentalists, as these variations are imparting negative impact on global crop production leading to starvation condition and compromising food security worldwide (Vaughan *et al.*, 2018; Dhankher and Foyer, 2018).

Speth and Hass (2006) have estimated that half of the world's tropical and temperate forests are already gone. One-third of the mangroves and half of the wetlands have also disappeared. The rate of disappearance of species has increased by 100 to 1000 times more than the normal. Severe habitat loss occurred due to indiscriminate anthropogenic activities like dumping of wastes, conversion of wetlands into terrestrial habitats, overgrazing of ground vegetation, deforestation, increased soil erosion and so on (Prakash and Verma, 2022). Extreme environmental conditions around the globe have affected all living organisms such as plants, animals, fishes as well as human beings (Kanojia and Dijkwel, 2018). Hector and Bagchi (2007) have described changes in the stocks of biomass can also influence the net amount of carbon removal from the atmosphere. Due to frequent changes in the environment and increased frequency of flood, rainfall, drought and fluctuation in the temperature, out-break of pests are anticipated to decrease the production of crops leading to starvation conditions worldwide (Dhankher and Foyer, 2018). Global climate change may be the biggest disaster in the history of human beings. Covid-19 is one of the such types of disaster popularly known as Corona pandemic (Roy *et al.*, 2020; Verma and Prakash, 2020).

The two major issues of the next century are climate change and food insecurity. Many countries' people are affected by malnutrition which hinders sustainable development. Sustainable development is a long term need with environmental ethics (Ashok, 2019). Tito *et al.* (2018) have suggested that the adverse

weather condition has considerably affected the food security and global agricultural yield. This review is an attempt to estimate the effects of climate change on agricultural crops, food security and biodiversity.

### **Effects of Climate change on Agricultural crops and food security**

Due to rise in the temperature, the pattern of weather and climate has been altered around the world, causing drought or flood in most of the regions (Marengo and Espinoza, 2016). The frequency and intensity of these events are projected to increase as a result of global rise in green-house gases. Global climate change has given rise to shifts in the distribution of plant species, water dearth, reduced agricultural yields and the drastic decline of vegetation. The impacts of climate change on vegetation dynamics vary across various countries around the globe based on region and climate zone (Munang *et al.*, 2013). An unexpected variation in the rainfall and weather conditions like drought, flood and severe heat waves may be due to the rise in CO<sub>2</sub> concentration across the globe (IPCC, 2014). Most of the studies suggest that large scale annual fluctuations in the climate and weather are caused by the changes in the oceanic circulation and the atmospheric pressure due to rise in the temperature (Zhao *et al.*, 2010, Kalisa *et al.*, 2019). Global climate changes have a direct impact on the ecosystem drivers such as flooding, invasion of alien species and severe drought ion as well as the timing of vegetation greening or recovery from stress conditions (Lovejoy, 2014). Due to increase in the CO<sub>2</sub> concentration variations have been the major threat to the terrestrial ecosystem and sustainable human settlement. Spatial and temporal variation of regional climate influence the phenology of plants and vegetation. A rise in the temperature affects the vegetation dynamics and the emergence of environmental trends like carbon emission threats to the functioning of the ecosystem (Piao *et al.*, 2019).

Due to anthropogenic activities, change in the climate brings the drying and warming trend and shifting of monsoon, unprecedentedly increased warming climate. Sintayehu (2018) reviewed the impact of climate change on vegetation, biodiversity and concluded that it is vulnerable to

changing climate with complexity in the hierarchy and high influence in diversity. The effect of climate change and environmental variation also bring a number of stresses and damages in the agricultural crops as well as the vegetation. In most of the developed countries, agricultural yield is suffering due to the change in the environmental condition and excessive CO<sub>2</sub> accumulation which forced the agricultural scientists to develop new strategies to cope with less predictable challenges (Rosenzweig *et al.*, 2014). Global change also influences food security by disturbing the agro-ecological environment and putting pressure on the growth and circulation of income and consequently increasing the necessity of agricultural products. The environmental condition with excessive fluctuation in temperature favours for the pests and insect outbreak that can affect the production of crops (Schmidhuber and Tubiello, 2007). Recent studies reported that developed countries have more vulnerability towards the global climate changes than the developing countries or states (Lesk *et al.*, 2016). Winkel *et al.* (1997) reported that a rise in temperature and water deficit influences the growth and phenology of pearl millet grown in Sahelian conditions. Experiments conducted by Zhao *et al.* (2017) explained the impact of climate change on the major cereal crops. They found a significant reduction in the yield of maize (7.4%), wheat (6%) followed by 3.2% reduction in rice and 3.1% in soybean. This suggests that climate change has influenced food security in a very complicated manner. UV-B radiation and excessive emission of green-house gases also influence the crop yield by enhancing the global temperature (Ambasht and Agrawal, 1997, 1998, 2003; Ambasht and Ambasht, 2005).

Morin *et al.* (2010) and Klien *et al.* (2013) have studied the phenology and reproductive process of European oak and Mediterranean Pine respectively and reported that phenology is affected by both precipitation and temperature. Richardson *et al.* (2013) consider that climate change will result in further advancement of vegetation's growing period in winter-spring and also earlier onset and longer summer drought period. A climate change impact on vegetation also impoverishes the soil. Climate change threatens to shift vegetation and disrupt the ecosystems (Gonzalez *et al.*, 2010). They reported that the boreal, tropical and temperate ecosystems have shown change in the

biome in the 20<sup>th</sup> century and one tenth of global land may be very highly vulnerable to climate change. Maximum vulnerability may be due to potential changes in wildfire, while evergreen and boreal conifer forests are predicted to be least vulnerable.

### **Effects of Climate change on Biodiversity**

Biodiversity is fundamental to ecosystem structure and function and provides goods and services that humans derive from the natural ecosystem. Due to anthropogenic activities and climate change there is loss of global biodiversity, which is not good for sustainable development and environmental ethics (Ambasht and Ambasht, 2002; Fardila *et al.*, 2017; Ashok, 2019). Habitat modification, climate change, invasive alien species are known to cause a threat to biodiversity. The ozone layer depletion, global warming, acid rain, precipitation, environmental pollution etc. are contributing to the loss of biodiversity (Sonwa *et al.*, 2017; Kumar and Verma, 2017).

In the next 50-100 years, due to global warming and anthropogenic activities severe biodiversity loss at all levels i.e. gene, species and ecosystem is expected. However, only a few studies have assessed the climate induced biodiversity extinctions. Monzon *et al.* (2011) have found that only 19 species are extinct due to global climate change. According to the IUCN Red List of threatened species, it is predicted that a large number of species are threatened due to climate change, extreme temperature rise and drought (IUCN, 2016). The extinction rates of species are increased due to severe drought, current velocity and enhanced rate of climate change (Brito-Morales *et al.*, 2018). Midgley *et al.* (2002) have studied the impact of climate change on the plant diversity in Cape Town, South Africa and found 11% species are at the risk of extinction and 42% of the species size are reduced.

It is anticipated that biodiversity is most vulnerable to climate change. Most of the species diversity is significantly altered due to climate change. Walther (2010) reported that loss of natural habitat and shifting of natural habitat have more serious impacts on species population size. Due to the excessive load of pollution, destruction of natural habitat, deforestation and

fragmented ecosystems; rare species are facing a real threat. Forest fires are also an important threat to biodiversity. As a result of drought and shortage of water, decreased rainfall, most of the African countries including Ethiopia are facing considerable effect on livestock (MacDonald and Simon, 2011). To maintain the balance of ecosystem, interaction between the plants and animals, biodiversity needs to be understood, hence promoting its conservation and protection by designating the hotspots as biosphere reserves, increasing afforestation, reforestation and agroforestry practices seem fruitful.

## CONCLUSIONS

Climate changes are an alarming threat worldwide by disrupting agriculture and food crops. The world's environment is facing a big challenge as warming effect due to rapid industrialization, urbanization and poisonous gases emission. Fluctuation in the temperature and variations in rainfall spells are very crucial indicators of environmental stresses. It is also a big challenge to overcome the imbalance in agriculture caused by climate change.

In order to reduce biodiversity loss, public awareness and moral responsibility may be proved fruitful. There is a lack of research dealing with the interaction between different drivers of global climate change. Establishment of few biosphere reserves and national parks are not enough. Habitat protection is the most effective means of protecting biodiversity at all levels. Partnership of local people and ensuring sustainability should be the guiding principles of biodiversity conservation. In order to maintain the balance of the ecosystem, afforestation, reforestation and agro forestry practices should be implemented on a large scale. More protected areas should be developed to maintain the harmony of the ecosystem with nature. Biodiversity conservation must be treated as a continuous process, with an ecologically holistic approach, economic returns, educational and tourism values, and sustainable character.

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