

Climate Change and Sustainability of Agriculture

Minakshi Neware

Department of Agricultural Botany, Dr. PDKV Akola- 444104, Akola (Maharashtra)
E-mail: neware.sonu@gmail.com

Abstract—This paper explains how climatic change affects on environment and living things. Although the earth's climate has been slowly evolving over millions of years, rapid changes have occurred in recent times due to the activities of humans. Climate change is now recognised as something which is affecting all our lives. Such global climate changes will affect agriculture considerably through its direct and indirect affect on crops, livestock, pest and diseases and soils, thereby threatening the food security, an important problem for most of the developing countries. It caused by anthropogenic greenhouse gases has emerged as one of the most important environmental issues facing the international community. Greenhouse gases particularly fossil fuel-based carbon dioxide emissions - are accumulating in the atmosphere as a result of human activities, and the ongoing increase in greenhouse gas concentrations is expected to raise the global average temperature and cause other changes to the climate. The contents covered in this paper a brief overview of how and why global climate has changed over the past century and will continue to change in the future and what are the adaptive measures.

1. CLIMATE

Average weather conditions of temperature, rainfall, humidity, wind velocity, sunshine hours prevailing in geographical area over a period of time is called climate.

2. CLIMATE CHANGE

Climate change refers to any change in climate over time, weather due to natural variability or as a result of human activity.

3. CAUSES OF CLIMATE CHANGE

The causes of climate change are Natural and Anthropogenic which are listed below:

4. NATURAL

- Earth's tilt
- Volcanoes
- Ocean currents
- Temperature

- Precipitation
- Atmospheric CO₂

5. ANTHROPOGENIC

- Large scale use of fossil fuels for industries
- Deforestation
- Extensive use of natural resources
- Population pressure
- Industrialization contributes 3/4th of CO₂ emissions and 1/5th of CH₄ emissions besides releasing nitrogen oxides and carbon monoxides.

6. CONSEQUENCES (IMPACTS) OF CLIMATE CHANGE

The consequences of climate change are below:

- Global warming
- Ozone depletion
- Storms
- Heat waves
- Sea level rise
- Precipitation
- Droughts
- Floods
- Increases in allergy inducing pollen
- Shrinking water sources
- Ocean acidification
- Melting glaciers
- Natural agro-ecosystem disruption
- Forest fires

- Soil health
- Pest and disease outbreak
- Loss of wetlands
- Rapid and continued loss of biodiversity

7. CONTRIBUTION OF AGRICULTURE TO GLOBAL WARMING

Agriculture contributes 28% of total GHG emissions from India. For increased food production, greater emphasis has to be laid on fertilizer application and other inputs resulting in more emission. Increase in temperature leads to higher emissions even at current level of fertilizer consumption.

8. IMPACT OF CLIMATE CHANGE ON AGRICULTURE

The major impacts of climate change on agriculture are

- Destabilization in production and productivity
- Less availability of irrigation
- Reduction in fertilizer use efficiency
- Detrimental effect on fruits, vegetables, Medicinal and aromatic plants.

9. IMPACT OF CLIMATE CHANGE ON SOIL HEALTH

- Decrease in soil carbon
- Soil erosion due to denuding of forests and vegetation
- Shift in land suitability
- Increase in transient salinity
- Change in soil biology and microbial production

10. IMPACT OF CLIMATE CHANGE ON WATER RESOURCES

- Hydrological cycle change leading to floods and droughts
- Increase in water requirement of crops
- More salinity of ground water
- Adverse effect on aquatic eco-systems
- Snow-melt run off leading to rise in sea level

11. IMPACT OF CLIMATE CHANGE ON PEST AND DISEASE OUTBREAK

Climate change interacts with land, water, vegetation and atmosphere

- Rainfall and moisture are important for dispersal, infection and survival of pests and diseases
- Warmer and dried condition prevailing over 18-22 days at 20⁰ C and 10-11 days at 30⁰ C favours attack of thrips on cotton
- Prolonged drought coupled with high temperature leads to outbreak of White flies on cotton
- Jassids outbreak on cotton commensurate with high temperature, RH and rainfall
- Drizzling rains and poor light build up aphid population in cotton
- Low temperature and high humidity favours multiplication of Mealy bug on cotton
- The optimum temperature for conidial germination of dahiya on cotton is 25-30⁰ C
- Prolonged drought conditions followed by heavy downpour favour wilt of cotton
- Excessive moisture/ moisture stress in soil affects nutrient uptake leading to reddening of cotton

12. CLIMATE CHANGE AND AGRICULTURE

Causes (s)	Effect
Drought situation	Complete crop failure
Dry spell	Lower yields
Cloudy weather at harvest	Disease incidence affecting marketability
Onset of late rains Early withdrawal of rains	Powdery mildew and shoot fly Withering and drying
Heavy downpour	Flooding, heavy soil erosion and loss of nutrients
Untimely rains at harvest	Mold infection in sorghum, affect fiber quality in cotton, shattering in soybean pods and sprouting in groundnut
Diurnal changes in temperature and humidity	Leaf sugary disease of sorghum or reddening of cotton leaves
Absence of threshold temperatures	Retard crop growth and reproductive potential of pests
Cold and hot waves	Affect marketability of fruit crops
Onset of fog, dew and frost	Physiological maturity, plant protection measures
Sunshine hours over short span	Reduction of photosynthesis and yield

Wind speed	Increase potential evapo-transpiration, soil water run-off
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13. IMPACT OF CLIMATE CHANGE ON WHEAT PRODUCTION

Wheat production in Maharashtra is likely to be reduced by 50% due to less moisture in soil, inadequate rainfall, aphid attack and change in temperatures. Due to temperatures rise of 2 to 5⁰ C during November, 2⁰ C in December and 6⁰ C in January about 20% reduction in yield is expected.

14. CLIMATE CHANGE AND ANIMAL HEALTH

- Rainfall, solar radiation, temperature, humidity, windfall, affects animal health
- Cold stress predisposes to infection enteritis
- Wind spreads foot and mouth disease
- Spatial and temporal disease are Avian influenza, Trypanosomiasis, Blue tongue, Encephalities
- Communicable diseases include Black quarter, Chicken gunya, Dengue, Bird flu, Malaria and Filaria

15. CLIMATE CHANGE AND FISHERIES

- Increase nutritional stress
- Reduce production
- Hamper reproductive cycle
- Increase morbidity due to diseases

16. CLIMATE CHANGE AND HUMAN HEALTH

Heat waves, extreme weather, temperature, precipitation, results in air and water pollution, depletion of ozone layer, increased viral infection, cholera, malaria, skin diseases, cardiac and respiratory problems. The recent symptoms of climate change has been the outbreak of cholera in Bangladesh due to rise in sea level (El-Nino).

17. ADAPTING CHANGE AND HUMAN HEALTH

Same of the adaptive measures to sustain the climate change in agriculture are listed below:

- Change in land use and input management
- Development of resource conservation technologies
- Improved risk management through early warning and crop insurance
- Improved management of livestock
- Use of nitrification inhibitors

- Improving water, nitrogen and energy use efficiency of crop
- Crop diversification
- Development of new genotypes tolerant to multiple stresses, drought, flood, heat, salinity, pest and diseases
- Carbon sequestration in soils

18. CLIMATE CHANGE COMPONENT AND ADAPTIVE MEASURES

Components of climate change	Adaptive measure
Late monsoon	Growing short duration varieties with less water requirement; growing of green gram, Bengal gram instead of pigeon pea, bajara in place of Jawar, Sunflower, intercropping, sole crop options
Early withdrawal of rains	Induction of early maturity, selection of crop as per land capability
Heavy rains	Soil erosion resistant crops, soil amendments, growing baru, dhaincha, khas grass, FYM, press mud, <i>nala training</i> sunhemp.
Untimely rains at harvest	Replacing sorghum with maize, intercropping, bringing area under sunflower, growing castor as sole crop, growing non-shattering soybean types
Wind speed	Decrease potential evapo-transpiration, increase forest cover
Sunshine	Growing photo positive and thermo tolerance crops

19. POLICES TO MITIGATE CLIMATE CHANGE

The following policies are needed to be adapted to mitigate the climate change.

- Afforestation
- Cleaner and lesser carbon intensive fuel
- Carbon budgeting and trading
- Public awareness campaign
- Adaption of participatory approaches
- Providing scientific personnel
- Minimizing land degradation
- Recycling of municipal and industrial waste

20. CAPACITY BUILDING

- Establish automatic weather station
- Enhance agro-economic modelling system

- Intensify climate literacy among stakeholders
- Strengthen basic research on biotic and abiotic stress

21. CONCLUSION

Climate change, the outcome of the “Global Warming” has now started showing its impacts worldwide. Climate is the primary determinant of agricultural productivity which directly impact on food production across the globe. Agriculture sector is the most sensitive sector to the climate changes because the climate of a region/country determines the nature and characteristics of vegetation and crops. Increase in the mean seasonal temperature can reduce the duration of many crops and hence reduce final yield. Food production systems are extremely sensitive to climate changes like changes in temperature and precipitation, which may lead to outbreaks of pests and diseases thereby reducing harvest ultimately affecting the food security of the country. The net impact of food security will depend on the exposure to global environmental change and the capacity to cope with and recover from global environmental change.

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