Impact of Global Climate Change on Agriculture

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Abstract

Agriculture and climate change are linked—crop yield, biodiversity, and water use, as well as soil health are directly affected by a changing climate. Climate change, which is largely a result of burning fossil fuels which adversely affecting the Earth's precipitation, temperature, and hydrological cycles. Continued changes in the compounded climate factors can decrease plant productivity, resulting in price increases for many important agricultural crops.

Key words*: climate change, crop, yield, plant productivity*

INTRODUCTION

Climate is the average weather of given region or area over a given period of time. It is a result of delicate balance between the sun, topography, oceans, atmosphere, plants, water system, and all living organisms. The greenhouse effect produces the relatively warm and hospitable environment near the earth's surface. However, the increased level of greenhouse gases (GHGs) (carbon dioxide (CO2), water vapor (H2O), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) etc) due to anthropogenic activities has contributed to an overall increase of the earth's temperature and finally leading to a global warming. The average global surface temperature have increased by 0.74 ^{o}C since the late 19th Century, then temperature increase by 1.4 ^{o}C - 5.8 ^{o}C by 2100 AD with significant regional variations (IPCC, 2007).

Table 3:Estimates of future levels of CO_2

Year	CO_2 ppm
2000	369
2010-2015	388-398
2050/2060	463-623
2100	478-1099

CAUSES OF CLIMATE CHANGE

Table 1: Atmospheric composition (Dry atmosphere by volume)

Gas	Volume	Gas	Volume
Nitrogen (N_2)	780,840 ppm (78.08%)	Hydrogen (H_2)	0.55 ppm
Oxygen (O_2)	209,460 ppm (20.94%)	Water vapor (H_2O)	Typically 1% to 4%
Argon (Ar)	9,340 ppm (0.934%)	Nitrous oxide	0.5 ppm
Carbon Dioxide(CO_2)	381 ppm	Xenon	0.09 ppm
Neon (Ne)	18.18 ppm	Ozone	0.0 to 0.07 ppm
Helium (He)	5.24 ppm	Nitrogen Dioxide	0.02 ppm
Methane (CH_4)	1.745 ppm	Iodine	0.01 ppm
Krypton (Kr)	1.14 ppm	Ammonia	Trace

Table 2: Overview on greenhouse gases conc., life time and their global warming potential (GWP)

GHGs	Concentration		Life time (Years)	GWP
	1750	1998		
CO_2 (ppm)	280	360	120	1
CH_4 (ppb)	700	1745	14.5	23
N_2O (ppb)	270	314	120	296
CF_4 (ppt)	40	80	> 50000	5700
C_2F_6 (ppt)	0	3.0	10000	11900
SF_6 (ppt)	0	4.2	3200	22200
Tropospheric ozone (ppt)	25	34	0.01-0.05	---

A. Natural: i) Continental drift, ii) Volcanoes, iii) Ocean currents, iv) Earth's tilt, v) Comets. Meteorites and asteroids
B. Human induced: i) Burning of fossil fuel, ii) Change in land use pattern, iii) Industrialization, iv) Urbanization, v) Deforestation, vi) Transportation

DIRECT OBSERVATIONS OF RECENT CLIMATE CHANGE

Global average air temperature**:** Updated 100-year linear trend of 0.74 [0.56 to 0.92] ^oC for 1906-2005, larger than corresponding trend of 0.6 [0.4 to 0.8] ^oC for 1901-2000 given in TAR, average ocean temperature increased to depths of at least 3000m ocean has absorbed 80% of heat added seawater expansion and SLR.

HEAVIER PRECIPITATION, MORE INTENSE AND LONGER DROUGHTS

More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics.

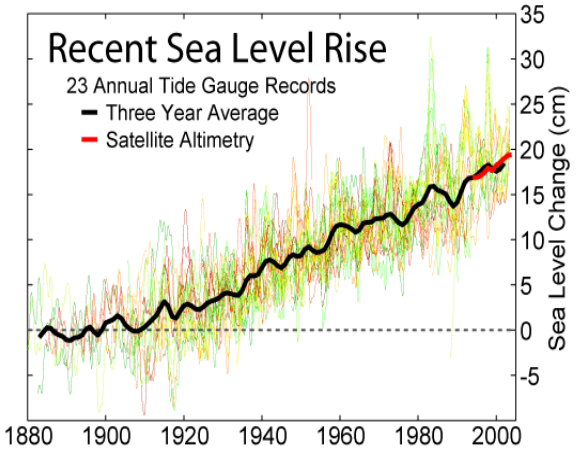


Fig no.1

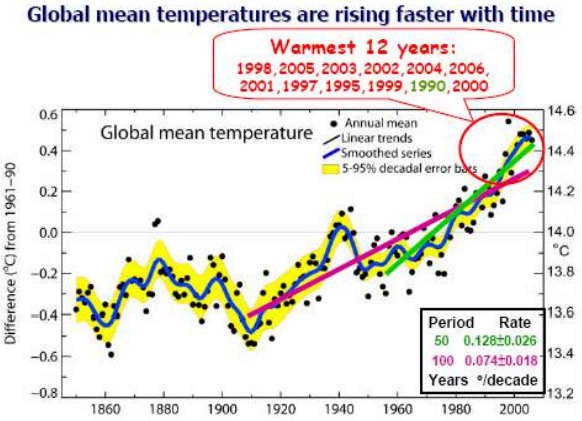


Fig no.2 *IPCC, 2007*

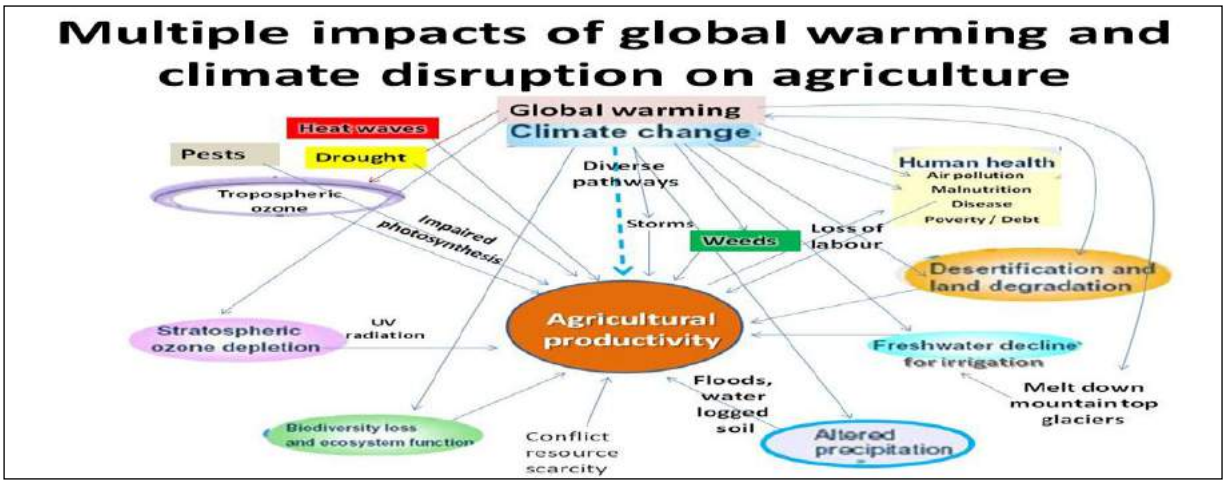
The frequency of heavy precipitation events has increased over most land areas. It is very likely that hot extremes, heavy precipitation and heat waves events will continue to become more frequent and that future tropical cyclones (typhoons and hurricanes) will become more intense.

Fig no. 3

Fig no. 4

EVIDENCE ON LOSS OF BIODIVERSITY

Since the 1950s, Europe has lost more than half of its wetlands and most high–nature–value farmland; and many of the EU's marine ecosystems are degraded. At the species level, 42% of Europe's native mammals, 45% of butterflies, 43% of birds, 30% of amphibians, 52% of freshwater fish and 45% of reptiles are threatened with extinction; most major marine fish stocks are below safe biological limits. Some 800 plant species in Europe are at risk of global extinction. This loss of species and decline in species' abundance is accompanied by significant loss of genetic diversity. Since the late 1970s, an area of tropical rain forest larger than the EU has been destroyed, largely for timber, crops such as palm oil and soy bean, and cattle ranching. Wetlands, drylands, islands, temperate forest. Mangroves and coral reefs, are suffering proportionate losses. Species' extinction rates are now around 100 times greater than that shown in fossil records and are projected to accelerate,



threatening a new 'mass extinction' of a kind not seen since the disappearance of the dinosaurs.

Table 4: Climate change scenarios for India

Year	Season	Increase in temperature, ^{0}C		Change in rainfall, %	
		Lowest	Highest	Lowest	Highest
2020s	Rabi	1.08	1.54	-1.95	4.36
	Kharif	0.87	1.12	1.81	5.10
2050s	Rabi	2.54	3.18	-9.22	3.82
	Kharif	1.81	2.37	7.18	10.52
2080s	Rabi	4.14	6.31	-24.83	-4.50
	Kharif	2.91	4.62	10.10	15.18

Source: Lal et al., 2001

Some Specific Impacts on India:

i) Stress on the land and water resources,
ii) Threat to ecosystems and biodiversity,
iii) Agriculture: Yields of major crops expected to decline,
iv) Potential for drier conditions in arid and semi-arid parts of India
v) Greater vulnerability to extreme climate events like typhoons, cyclones, droughts and floods, particularly in coastal areas.

IMPACT ON AGRICULTURE

Factors effecting crop production in changing climate

Evidences on Agriculture

- Most of the studies and models on impacts of climate change on agricultural production systems indicate that there will be negative effects on crop yields over the next century.
- Changing of wheat sowing time from mid November to mid December.
- Cultivation of temperate fruits in much higher altitude than earlier
- Rice yields are decreased by 3% to 10% under a scenario of 1.50C rise in temperature and a 2 mm day-1 increase in precipitation.(Saseendran *et al.*, 2007)
- Yield losses would be more in case of winter wheat than that of rice and that the associated economic impacts would affect more adversely the lower income groups of the society.(Kumar and Parikh, 1998)
- Fankhauser (1995) has estimated the annual forestry losses to be US$1.8 billion in the OECD and US$2 billion for the world as a whole due to the climate change.
- Decreased precipitation and increased temperature and a, could have adverse effect on forests

(Ravindranath N H and Sukumar R (1998).

- Modification in cropping pattern from wheat to maize in Bihar.

IMPACT OF CLIMATE CHANGE ON SOIL

Organic matter content: Rise in atmosphere CO_2 concentration increase photosynthetic rates and water use efficiencies and increase in organic matter supply to soil very fast, that's result carbon concentration reduce simultaneously.

Microbial activity: Increase in temperature, in which soils are warm, microbial activity will be increase.

Changes in clay mineral surfaces:

1. Hydrolysis- means removes silica and basic cations.

2. Cheluviation- removes maximum Al and Fe.

3. Ferrolysis- decreases CEC by altering Al interlayering.

4. Dissolution of clay minerals- produces Al salt and amorphous silica.

5. Reverse weathering- creates montmorillonite.

Mitigation:

1. Drought proofing by mixed cropping

2. Selecting genotype in crops that have a higher per day yield potential to counter

3. Yield loss from heat-induced reduction in growing periods.

4. Participatory and formal plant breeding to develop climate-resilient crop varieties that can tolerate higher temperatures, drought and salinity.

5. Resource conservation

6. Frost management by irrigation

7. Heat stress alleviation by frequent irrigation

8. Shelter belts

9. Invent short duration varieties/crops

10. Altering fertiliser rates to maintain grain or fruit quality and be more suited to the prevailing climate

11. Changing the amounts and timing of irrigation

12. Soil moisture conservation (e.g. crop residue retention)

13. Altering the timing or location of cropping activities

14. Develop a long-term land use plan for ensuring climatic resilience and food security.

15. Provide more funds to strengthen research for enhancing adaptation and mitigation capacity of agriculture.

CONCLUSIONS

Increased temperature hampered the grain filling which ultimately leads to reduction in yields. Poor verbalization occurs due to increase in extremes of weather elements. In general, climate changes have the potential to lead to large disruptions in agricultural sector in the state and have adverse impacts on food security.

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