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Impact of climate change on biodiversity and agriculture

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ABSTRACT

An attempt has been made to review the impact of climate change on biodiversity and agriculture thereby suggesting measures to mitigate these impacts. The spatial distribution of surface warming suggests a mean annual rise in temperature in north India by 3°C by 2050. However a marginal increase of 7-10 per cent in annual rainfall is projected over the sub-continent by 2080. There may be the chances that some species of trees, flora and fauna may vanish and others emerge out coupled with the loss of several hyper-thermo-sensitive crops. The global production may decrease in developing and increase in developed countries.

Keywords: Climate change; biodiversity; impact; temperature; rainfall

INTRODUCTION

Anthropogenic activities world over have exploited natural resources to meet their needs and have disturbed the ecosystem on the earth. The Inter-Governmental Penal on Climate Change (IPCC) projected an increase in global average temperature between 0.1-0.3°C per decade (Anon 2007). The impacts are more likely on fragile ecosystems like arid regions where hot environment, low and erratic rainfall conditions prevail and crops are sensitive to soil water (Rao and Saxton 1995). The PRECIS model for India showed an increase in an annual mean surface temperature by 3 to 5°C under A_2 scenario and 2.5 to 4°C under B_2 scenario with warming more pronounced in northern parts of India by the end of century. Warming is expected to be more in winter and post-monsoon seasons compared to south-west monsoon seasons (Kumar et al 2006). These climate changes are expected to alter the natural ecosystem in many parts of the globe. Agricultural ecosystems are subject to severe climatic inter-annual variability; these systems may become more vulnerable under the expected scenarios of climate and can be deleterious for agriculture and biodiversity.

Emission of GHG - an assessment

Kyoto protocol on climate change in 1997 emerged as a global issue because of its deeper relationship with agricultural production activities (Rogenzweig and Parry 1994) as they contribute to build up greenhouse gases particularly methane, nitrous oxide, water vapor, carbon dioxide and halocarbons. IPCC has reported enormous increase in the concentration of these gases over the last 200 years (Anon 2001). In the US approximately 6.6 tonnes of greenhouse gases are emitted per person per year.

Effect on temperature and rainfall

The spatial distribution of surface warming suggests a mean annual rise in temperature in north India by 3°C by 2050. Annual mean area averaged surface warming over the Indian sub-continent is likely to range between 3.5 and 5.5 by 2080 (Lal et al 2001) (Table 1). These projections show more warming in winter season over the summer. In case of rainfall a marginal increase of 7-10 per cent in annual rainfall is projected over the sub-continent by 2080. Nevertheless the study suggests a fall in rainfall by 5-25 per cent in winter while it would be a 10-15 per cent increase in summer.

Climate change and agriculture

The impact on global agricultural production is expected to be small due to climate change but regional vulnerability to food shortage may increase. Rogenzweig and Parry (1994) estimated the net effect of climate change on global production up to 5 per cent but production may decrease in developing and increase in developed countries. As per IUCC Doubling CO_2 concentration may increase the photosynthetic rates by as much as 30 to 100 per cent in C_3 plants such as wheat, rice and soybean whereas response in C_4 plants such as maize, sorghum, sugarcane, millets etc may remain as such (Anon 1992).

Climate change and biodiversity

Due to climate change scenarios the biodiversity and the configuration of forest ecosystems may alter. IPCC suggested a significant forest dieback towards the end of this century and beyond especially in tropical, boreal and mountain areas (Anon 2007). There are chances that some species of trees, flora and fauna may vanish and others may emerge out. Climate change may lead to the loss of several hyper-thermo-sensitive crops like Basmati rice, apple, saffron, cabbage, cauliflower, carrots and peas from their native habitats because of their specific hypothermal requirements for flowering, fruiting and development of aroma.

Implications of climate change

The crops with C_3 pathways may be benefitted while C_4 crops may remain unaffected due to climate change. Growth and productivity of C_3 crops increase directly by rising CO_2 levels but may be

Table1. Projected mean temperature and rainfall changes in the Indian sub-continent

Period	Season	Change in temperature (°C)		Change in rainfall (%)	
		Lowest	Highest	Lowest	Highest
2020s	Annual	1.00	1.41	2.16	5.97
	Rabi	1.08	1.54	-1.95	4.36
	Kharif	0.87	1.17	1.81	5.10
2050s	Annual	2.23	2.87	5.36	9.34
	Rabi	2.54	3.18	-9.22	3.82
	Kharif	1.81	2.37	7.18	10.52
2080s	Annual	3.53	5.55	7.48	9.90
	Rabi	4.14	6.31	-24.83	-4.50
	Kharif	2.91	4.62	10.10	15.18

offset by increased atmospheric temperature. The photosynthetic rate of C_3 crops increases mainly due to reduced photorespiration. The crops like fodder, sugarcane, potato and root foliage crops are likely to be benefitted. Water availability may become a serious problem affecting flora and fauna due to greater losses of moisture through elevated evapotranspiration. The coastal areas may have submergence situations due to rise in the sea level and coastal biodiversity may also be affected.

Strategies to mitigate the effect of climate change

1. The drought resistant cultivars should be evolved through research and development and by using the climate information strategically.
2. On farm micro-irrigation technologies should be devolved for efficient use of water. New agronomic practices and resource conservation technologies need to be fine -tuned. Organic farming can slice down the green house gases.
3. Strengthening the reforestation projects and prevention of deforestation for monitoring and regulating the GHG emission should be promoted for carbon sequestration. This can be achieved by preaching 'Each one, teach one and plant one' and rational use and conservation of forests and land resources.

4. Promoting the 'Reduce, re-use and recycle' slogan and switching over to the clean fuels and energy efficient technologies can make a difference to conserve healthy natural environment.

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