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Impact of Climate Change on Productivity of Fruit Crops and Measures to Adapt to Climate Change

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Abstract*—As compared to field crops, studies in relation to impact of climate change on fruit crops have been very confined and limited mainly due to their longer life cycle and perennial nature. The impact of climate change on fruit crops is likely to be more detrimental as compared to field crops as the adaptation capacity of shorter duration crops is generally greater than perennials. Climate change may affect the flowering and fruiting timing, maturity and quality of fruit crops to a great extent. It can also affect the spatial distribution pattern of these crops in order to meet the specific climatic requirement of crops. The temperate crops which possess an optimum thermal range may suffer greatly as compared to tropical crops. Rise in atmospheric temperature may enhance the growing period of tropical crops like mango, jack fruit, banana etc in north India especially during winter when growth is generally restricted greatly due to low temperature. This may also help in overcoming the problem of alternate bearing in mango in north India.*

Keywords: *Climate change, Temperate crops, Global warming, sustainability, Adaptation.*

1. INTRODUCTION

Global warming and climate change has emerged as an important global concern cutting across geographical and national boundaries. Global warming is defined as the increase in the temperature of globe due to transmission of incoming short-wave radiation from the sun and the absorption of outgoing long-wave radiation from the earth by GH gases. The phenomenon is called Greenhouse effect or more precisely called "Natural greenhouse effect".

The term Green house effect is derived from the phenomenon of warming effect that take place inside greenhouses (glasshouses) used for off-season cultivation in temperate areas. An increase in the concentration of greenhouse gases such CO_2 CH_4. N_20 in the atmosphere is thought to have been responsible for increasing the air temperature. This is called as *enhanced* greenhouse effect which is the additional effect induced by human activities**.**

2. MATERIALS AND METHODS

The information pertaining to impact of Climate change on fruit crops was gathered from different sources and presented in the following heads *viz*., implications of globalwarming, impact of globalwarming on Indian agriculture, **adaptation to** climate change, measures to adapt agriculture to climate change, globalwarming and biodiversity**, global warming and food** security, **global warming and food** consumption.

3. DISCUSSION

3.1. Implications of global warming

IPCC 2007

- Increases in the frequency of droughts and floods are projected to affect production negatively, especially in subsistence sectors at low latitudes.
- Regional changes in the distribution and production of fish species are expected due to continued warming, with adverse effects projected1for aquaculture and fisheries.
- Crop yields to increase slightly at mid to high latitudes for temperature increase of 1 -3°C, and then decrease beyond that.
- At lower latitudes, crop yields tend to decrease for even small temperature increases (1-2°C).
- Globally, the potential for food production is projected to increase with increases in 1-3°C temperature, but to decrease above this.

- Simple adaptations such as altered cultivars and planting times allow cereal yields to be maintained at or above baseline yields for modest warming.

3.2. Projected impacts of global warming on Indian agriculture

- Productivity of most crops may decrease due to increase in temperature and decrease in water availability especially in Indo-gangetic plains.
- Greater loss expected in Rabi as compared to Kharif season crops. Cultivation of wheat and other hypo-thermophilic crops like cauliflower, cabbage in central India and temperate crops like apple, cherry, plum, peach, in northern India are likely to be threatened by global warming.
- Reduced frequency of frost damage in Northern India is expected.
- Impacts on food quality could be variable depending on the magnitude of thermal increase and type of crop.
- Sustainability of endemic crops like Basmati rice and litchi could be severely affected by GW.
- Considerable effect on microbes, pathogens, and insects population and virulence.
- Crop models provide a useful framework to evaluate a whole range of crop interrelationships subject to climate change (Strand, 2000) but constraints from diseases have not been considered to any great extent (Chakravarthy *et al.,2000*).The most likely consequences of climate change would appear to be shifts in geographical distribution of hosts and pathogens and altered crop losses due in part to changes in efficacy of control (Coakley *et al*.,1999)
- Imbalance in food trade due to positive impacts on Europe and N. America, and negative impacts on tropical and sub-tropical countries like India, Brazil, Mexico
- Increasing temperature would increase fertilizer requirement for the same production targets and result in higher GHG emissions, ammonia volatilization and cost of crop production.
- Increased frequencies of droughts, floods, storm and cyclones are likely to increase production variability.
- Increased water, shelter, and energy requirement for livestock.
- Increasing sea and river water temperatures are likely to affect fish breeding, migration and cost and quality of agricultural produce.

3.3. Adaptation to climate change

***3.3.1. Natural or self adaptation*:** Crops and animals show varying ability to adapt them to warming through different adaptive mechanism such as shifting their optimum thermal range, escaping, avoidance, thermal cooling, stomatal closure, cutinization, waxination, development of heat shock protein, osmoregulation etc.

***3.3.2. Genetic adaptation*:** Breeding crop varieties for heat tolerance through conventional and modem breeding techniques. Screening heat tolerant crop genotypes followed by exploitation of desirable genes mainly from the germplasm adapted to such warmer condition.

3.3.3. Non-genetic adaptation: Agro-physiological manipulation such as dates of sowing frequent irrigation, higher dose of chemical fertilisation, crop diversification, green manuring etc. to reduce vulnerability to climate change. Identification of crop genotypes for faster grain growth rate with delayed leaf senescence under higher thermal regime

***3.3.4.* Biotechnological approaches:** *Selective transfer* from donor without major changes in genetic makeup.

3.3.5. Crop insurance: Reducing climatic risk of crop productivity through crop insurance.

3.3.6. Better support price and credits: Better support price of agricultural produce is and bank credits are essential for crop sustainability and to meet the additional adaptation cost of climate change

3.4. Measures to adapt agriculture to climate change

- Greater investments in adaptation research capacity by changing varieties, land use systems, resource conservation technologies, pest surveillance etc.
- Changes in policies e.g. incentives for resource conservation and use efficiency, pricing of resources, credit for transition to adaptation technologies
- Investments in infrastructure for water management
- Relocation to more productive areas.
- Greater insurance coverage for the farm.
- Improved communication of climate changes and options to adapt them.
- Irrigation water, fertilizer and machinery.
- Environmental, social and economic costs of adaptation could be high.
- Marginal and small farmers may not be able to bear coping strategies

3.5. Global warming and biodiversity

- Global warming may lead to the loss of several hyper - thermo-sensitive crops viz., basmati rice, apple, cherry, saffron cabbage, snowball cauliflower, carrot, pea, etc. from their native habitats because of their specific hypo-

thermal requirement for flowering, fruiting and aroma development.

- Several C_3 crops (wheat, potato, beets, cauliflower, cabbage etc.) may be replaced by C_4 crops like maize, sorghum and sugarcane especially in those areas where these C_3 crops are grown at their upper thermal limit. Replacement of wheatby maize during winter season in Bihar could be as an example of such cases.
- Vulnerability of tropical/temperate crops due to coastal inundation and loss of biodiversity.
- Sex determination in some animal like crocodile and plants may also be affected by GW, which may lead to their spatial loss.
- Finally the spatial and temporal cropping pattern may be affected in future

3.6. Global warming and food security

Food security is a major problem around the world both in developed and developing countries. The efforts should not only be made toward increased dependency on trade but towards attaining self-sufficiency by each nation or a group of nations. The large countries like India, Brazil and Mexico where large area of arable lands are still under rain fed agriculture and thus food production in these areas is highly uncertain and risky because of their greater vulnerability to natural calamities such as drought, high temperature etc. Thus any changes in climatic components resulted from globalwarming may lead to the problem of food security at regional and national levels. Even in irrigated agriculture high temperature stress especially during vegetative and grain filling stages has been found determental in wheat crop and low temperature during the reproductive growth phase has been reported to begretrimental in rice and maize crops.

In order to maintain the global, national and regional food production senario it is indispensable to change the crop production strategies such as crop varieties, alternative cropping, enhancement in input resources and their efficient utilization etc. to cope with changes in climate in days to come. Cultivation of tuber, root, bulb and rhizomatous crops instead of fruit/grain/seed crops in tropics could be an alternate source of food and energy in future.

3.7. Global warming and food consumption

It is expected that climate change due to global warming could cause significant reduction in crop productivity and production especially in the traditional regions of crop cultivation, but at the same time it is also anticipated that the food consumption both at regional and global scales is likely to be reduced markedly due to global warming as the food requirement of consumers especially human beings is drastically reduced by warming because less food will be required to generate metabolic energy to maintain body temperature.

Warming of course would enhance the water demands but diminish the food demands due to less consumption of food for less energy requirement to keep body temperature normal because warming of surroundings would reduce thermal loss of body as compared to cooling period where more food is required to keep the body temperature normal against rapid diffusion of body temperature.

There is a general principle that cooling enhances the appetite, warming impairs the same. Apart from less food requirement, global warming would also reduce the adaptation cost to combat the problem of cooling during winter by reducing the consumption of electricity and fuel and demands for warmer woolen cloths as well. This aspect of global warming could perhaps be beneficial to the society.

4. CONCLUSION

Overall the climate change will have a positive effect on Banana and Maize production. Caution is that, farmers have to adapt to climate change through changes in farming practices, new varieties, cropping patters and use of new technologies will help to ease the impact. The negative influence on climate change can be mitigated through developing-adapting existing technologies in other parts of country or world practiced in similar environment for same or any other crop.

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