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# CLIMATE CHANGE AND ITS PROJECTED IMPACT ON AGRICULTURE AND ALLIED SECTOR: THE FACTS WE SHOULD KNOW

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## ABSTARCT

Global climate change is a shift in the long-term weather patterns that characterize the regions of whole world. In long term, the climatic change could affect agriculture in various ways such as quantity and quality of crops in terms of productivity, growth rates, moisture availability, transpiration rates and photosynthesis etc. Climate change is likely to directly affect food production across the world. Enhanced mean seasonal temperature can diminish the duration of crops and hence results in shrinking in yield. In regions where temperatures are nearly close to the physiological maxima for crops, warming will affect yields more instantly (IPCC, 2012). The main causes of climate change through modification in atmospheric composition can also influence food production directly by its impacts on crop physiology. The impact of agriculture's contribution to global climate change, and climate change's negative influence on agriculture, are severe which is projected to have a great influence on food production and may threaten the food security and thus require unique agricultural measures to combat with.

**KEYWORDS:** Climate Change, Food Security, Global Warming, Physiological Maxima

## INTRODUCTION

Indian agriculture is highly prone to risks due to climate change; especially to drought, because 2/3$^{rd}$ of the agricultural land in India is rain fed and evens the irrigated system is dependent on monsoon rain. It can affect agriculture through their direct and indirect effects on the crops, soils, livestock and pests. Increase in atmospheric $CO_2$ has a fertilization effect on crops with $C_3$ photosynthetic pathway and thus promotes their growth and productivity. Increase in temperature can reduce crop duration, increase respiration rates, alter photosynthesis process, affect the survival and distribution of pest populations and thus develop new equilibrium between crops and pests, hasten nutrient mineralization in soils, decrease fertilizer use efficiencies and increase evapo-transpiration. Climate change also has considerable indirect effect on agricultural land use in India due to availability of irrigation water, frequency and intensity of inter and intra seasonal droughts and floods, soil organic matter transformations, soil erosion, changes in pest profiles, decline in arable

areas due to submergence of coastal land and availability of energy. Not only agriculture but the allied sectors like animal husbandry, fishery are also affected from projected impact of climate change. Anthropogenic influence on the atmospheric system is evident from the increasing green house gas concentrations in the atmosphere and positive radiative forcing. Climate has warming of $0.85^0$C over the period 1880 to 2012. Natural variability accounted only for $\pm 0.1^0$C. The upper 75 mt. of ocean warmed by $0.11^0$C per decade over the period 1971 to 2010.The pH of ocean water decreased by 0.1 (26% increase in acidity) and global mean sea level has risen by 0.19mt (1901-2010). Further, it has projected that the mean surface temperature and sea level may increase by $0.3^0$C to$1.7^0$C and 0.26 to 0.54 mt for representative concentration pathways (RCP) $2.6^0$C to $4.8^0$C and 0.45 to 0.81mt for RCP 8.5, respectively by 2181-2100.The impact will be particularly severe in the tropical areas, which mainly consists of developing countries like India.

**Predicted Effects of Climate Change on Agriculture over the Next 50 Years**

**Table 1**

| Sl. No. | Climatic Elements | Expected Changes by 2050's | Confidence in Prediction | Effects on Agriculture |
|---|---|---|---|---|
| 1. | $CO_2$ | Increase from 360 ppm to 450 - 600 ppm (2005 levels now at 379 ppm) | Very high | Good for crops: increased photosynthesis; reduced water use |
| 2. | Sea level rise | Rise by 10 -15 cm Increased in south and offset in North by natural subsistence/rebound | Very high | Loss of land, coastal erosion, flooding, salinisation of groundwater |
| 3. | Temperature | Rise by $1\text{-}2^0$C. Winters warming more than summers. Increased frequency of heat waves | High | Faster, shorter, earlier growing seasons, range moving north and to higher altitudes, heat stress risk, increased evapo-transpiration |
| 4. | Precipitation | Seasonal changes by ± 10% | Low | Impacts on drought risk' soil workability, water logging, Irrigation supply, transpiration. |
| 5. | Storminess | Increased wind speeds, especially in north. More intense rainfall events. | Very low | Lodging, soil erosion, reduced infiltration of rainfall |
| 6. | Variability | Increases across most climatic variables. Predictions uncertain | Very low | Changing risk of damaging events (heat waves, frost, droughts floods) which effect crops and timing of farm operations |

**Impact of Climate Change on Livestock**

In present era, livestock sector contributes significantly to global food supply chain. In dairying, India ranks as the world's largest milk producer with an annual output of 1.16 million tones approx. With an annual growth rate of 4%, India's milk production accounts for 16% of the total global output. India has 52% of cattle population and 15% of buffalo population. It ranks third in sheep population and second in goat population in the world. From the scenario of global consumption, Americans consume more than 37 million tons of meat annually (U.S census Bureau, 2011). The U.S. livestock industry produced $100 billion worth of goods in 2002 (Philip K. Thornton, 2010). Changes in climate could affect animals both directly and indirectly.

Heat waves, which are projected to increase under climate change, could directly threaten livestock. A number of states have each reported losses of more than 5,000 animals from just one heat wave (Karl *et al*, 2009). Heat stress affects animals both directly and indirectly. Over time, heat stress can increase vulnerability to disease, reduce fertility, and reduce milk production.

Drought may threaten pasture and feed supplies**.** Drought reduces the amount of quality forage available to grazing livestock. Some areas could experience longer, more intense droughts, resulting from higher summer temperatures and reduced precipitation. For animals that rely on grain, changes in crop production due to drought could also become a problem.

Climate change may increase the prevalence of parasites and diseases that affect livestock. The earlier onset of spring and warmer winters could allow some parasites and pathogens to survive more easily. In areas with increased rainfall, moisture-reliant pathogens could thrive (Backlund, 2008).

Increases in carbon dioxide ($CO_2$) may increase the productivity of pastures, but may also decrease their quality. Increases in atmospheric $CO_2$ can increase the productivity of plants on which livestock feed. However, studies indicate that the quality of some of the forage found in pasturelands decreases with higher $CO_2$. As a result, cattle would need to eat more to get the same nutritional benefits.

Hence, we need to emphasize not only crops, livestock sector also sensitive significantly to climate change factors. Since the sector is important for global food and nutrition security perspective, it is need for hour to undertake researches on impact of climate change on various livestock sector and to develop model for analyzing climate change-livestock interaction.

**Impacts of Climate Change on Fisheries**

- With seafood production growing at the rate of four per cent per annum since 2012, India's aquaculture feed demand is to touch 7 million tonnes by 2017-18 (FAO report, 2016). In the country like USA, each year demand is about five million metric tons of fish and shellfish (U.S. Bureau of Economic Analysis, 2002). These fisheries contribute more than $1.4 billion to the economy annually (as of 2007). Many fisheries already face multiple stresses, including overfishing and water pollution. Climate change may worsen these stresses. In particular, temperature changes could lead to significant impacts.
- The ranges of many fish and shellfish species may change. Many marine species have certain temperature ranges at which they can survive. For example, cod in the North Atlantic require water temperatures below 54°F. Even sea-bottom temperatures above 47°F can reduce their ability to reproduce and for young cod to survive. In this century, temperatures in the region will likely exceed both thresholds (Karl *et al*, 2009).
- Many aquatic species can find colder areas of streams and lakes or move northward along the coast or in the ocean. However, moving into new areas may put these species into competition with other species over food and other resources.
- Some diseases that affect aquatic life may become more prevalent in warm water. For example, in southern England, lobster catches have declined dramatically. A temperature-sensitive bacterial shell disease likely caused the large die-off events that led to the decline (USDA, 2007).
- Changes in temperature and seasons could affect the timing of reproduction and migration. Many steps within an aquatic animal's lifecycle are controlled by temperature and the changing of the seasons. For example, in the Northwest warmer water temperatures may affect the lifecycle of salmon and increase the likelihood of disease.

Combined with other climate impacts, these effects are projected to lead to large declines in salmon populations (CCSP, 2008; Field et al., 2007).

In addition to warming, the world's oceans are gradually becoming more acidic due to increases in atmospheric carbon dioxide ($CO_2$). Increasing acidity could harm shellfish by weakening their shells, which are created from calcium and are vulnerable to increasing acidity (Field et al, 2007). Acidification may also threaten the structures of sensitive ecosystems upon which some fish and shellfish rely.

**Adaptation Strategies for Climate Change**

Potential adaptation strategies to deal with the impact of climate change are developing cultivars tolerant to heat and salinity stresses and resistant to flood and drought, modifying crop management practices, improving water management, improving new farm techniques such as resource conserving technologies (RCTs), crop diversification, improving pest management, better weather forecasts and crop insurance and harnessing the indigenous technological knowledge of farmers.

Efficient use of natural resources such as water is highly critical for adaptation to climate change. On-farm water conservation techniques, micro-irrigation systems for better water use efficiency and selection of appropriate crop based irrigation has to be promoted. Adjustment of planting dates to minimize the effect of high temperature induced spikelet sterility can be used to reduce yield instability so that flowering period does not coincide with the hottest period. Adaptation measures to reduce negative effect of increased climatic variability as normally experienced in arid and semi-arid tropics may include changing the cropping calendar to take advantage of the wet period and to avoid extreme weather events (e.g. typhoons and stroms), during the growing season. Cropping systems may have to change, to include growing suitable cultivars, increasing cropping intensities or diversification. For example, there is an urgent need for diversification of the conventional puddled transplanted rice and tilled wheat, to other cropping systems such as maize-wheat, pulse-wheat, maize-pulse, oilseed-wheat and direct seeded rice-wheat. The latter system have less demand for water and nutrient (with legume) and use resources more efficiently thereby increasing farmers' income and exhorting less pressure to the natural resource base.

Crop insurance schemes (Public and private), should be put in place to help the farmers in reducing risk of crop failure due to extreme climatic events. Micro-finance has been a success among rural poor including rural women. Low cost access to financial services could be a boon for vulnerable farmers. Recently, the government has launched the Pradhan Mantri Fasal Bima Yojana (Prime Minister Crop Insurance Scheme) to enable farmers avail insurance over against crop loss on account of natural calamities. Growing network of mobile telephony could further speed up SMS based banking services and help farmers have better integration with financial institutions.

Conservation agriculture and the resource conservation technologies (RCTs) have proved to be highly useful to enhance resource or input use efficiency and provide immediate, identifiable and demonstrable economic benefits such as reductions in production costs, saving in water, fuel and labour requirements and timely establishment of crops, resulting in improved yields (Fedoroff *et al*.,2010).

## SUMMARY

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 country. 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 environmental change and the capacity to cope with and recover from global environmental change. Coping with the impact of climate change on agriculture will require development of new cultivars combating with climate change and careful management of resources like soil, water and biodiversity.

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