IMPACT OF CLIMATE CHANGE ON AGRICULTURE: PRESENT AND FUTURE SCENARIO

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Climate change refers to significant changes in global temperature, precipitation, wind patterns and other measures of climate that occur over several decades or longer. The climate change brings out several long-term changes over the entire Earth, which include rising sea levels, shrinking mountain glaciers, ice melting at a faster rate than usual in colder region, increasing frequencies of drought, flood and heat waves, changes in vegetation and flowering time in plants etc. The largest driver of climate change is the emission of greenhouse gases, of which more than 90% are carbon dioxide (CO2) and methane. Since mid-20th century, burning of fossil fuels such as coal, oil, and natural gas for energy consumption is the main source of these emissions, with additional contributions from agriculture, deforestation, and manufacturing sectors.

Agriculture and fisheries are highly dependent on the climate and are getting affected by the climate change (Figure 1). According to climate scientist Ariel Ortiz-Bobea, climate change has basically wiped out about seven years of improvements in agricultural productivity over the past 60 years and it is equivalent to pressing the pause button on productivity growth back in 2013 and experiencing no improvements since then. Various reports showed increased crop yield in some controlled environment studies with increased temperature and CO2. This improved yield, however, is linked to proper nutrient levels, soil moisture, water availability, and other factors. Changes in the frequency and severity of heat waves, forest fire, storms, droughts and floods have been documented globally in recent years as a result of prevailing climate change. These unfavourable weather conditions have caused a slew of problems for farmers and food producers, and they pose a serious threat to food safety, which will only get worse in the future. While farming has generally become far more efficient in recent decades, it is increasingly threatened by heat waves that exhaust farm workers and withering various crops. Concurrently, increasing water temperatures are likely to cause the habitat shift of many fish and shellfish species and further disruption of ecosystem and biodiversity loss. Water resources for food production will be affected through changing rates of precipitation and evaporation, ground water levels, and dissolved oxygen content. Climate change, in general, may make it more difficult to grow crops, raise animals, and catch fish in the same manner and areas as in the past.

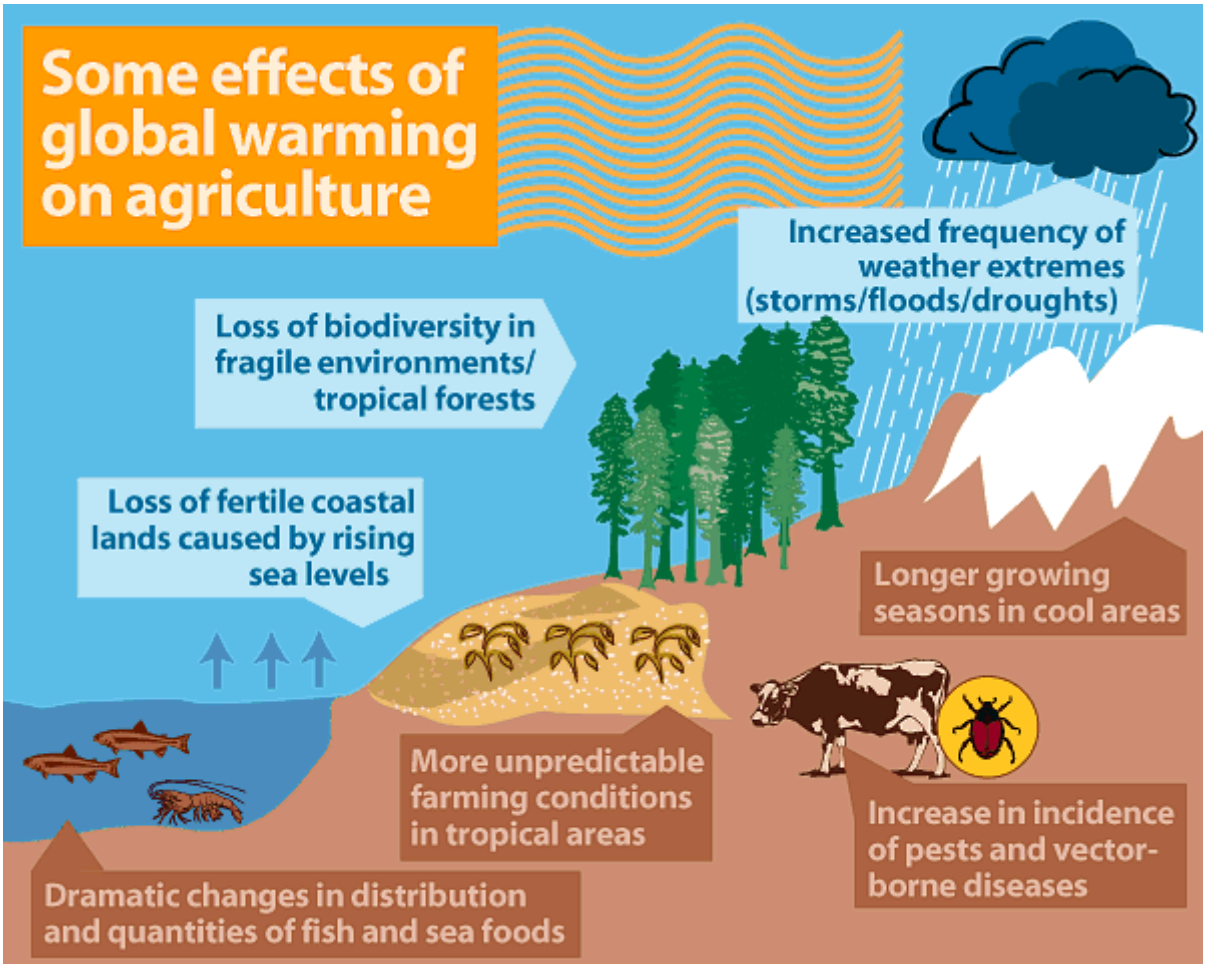

Figure 1. Summary of global warming effects on agriculture (Source: http://www.fao.org/News/FACTFILE/FF9721-E.HTM)

IMPACT OF CLIMATE CHANGE ON CROP PRODUCTION

Higher CO_2 levels have significant effect on crop yields. Some laboratory experiments suggest that elevated CO_2 levels can increase plant growth and crop yield. However, other factors, such as appropriate temperatures, ozone, water and balanced nutrient must be met to achieve the increased crop yield with increasing CO_2. However, these conditions are difficult to be met under prevailing climate change and resulting temperature change, flood, drought and other constraints. Therefore, climate change may counteract the potential increases in yield due to elevated CO_2. For example, if temperature exceeds a crop's optimal level with insufficient water and nutrients availability, yield increases may be reduced or reversed. Elevated CO_2 has been found to be associated with food and fodder quality loss due to reduced protein and nitrogen content in alfalfa and soybean plants. Therefore climate change can reduce the ability of pasture and rangeland to support grazing livestock by negatively affecting the grain and forage quality. While increased CO_2encourages plant growth, it also lowers the nutritional value of most food crops. Most plant species, including wheat, soybeans, and rice, have lower protein and essential mineral concentrations when atmospheric carbon dioxide levels rise. Warmer temperatures, wetter climates, and higher CO_2levels favor the growth of many weeds, pests, and fungus. Therefore, weed and pest ranges and distributions are anticipated to expand as a result of climate change. To combat this situation the application of pesticide will be increased. The rising temperature and CO_2 will pose as threat to human health by reducing nutritional value of crops along with increased pesticide use due to increased pest pressures and reductions in the efficacy of pesticides.

Frequency and severity of drought are different for different regions. For example, drought management might be difficult in regions where rising summer

temperatures lead to drying up of soils. While more irrigation may be possible in certain areas, water resources may be limited in others, leaving less water available for irrigation when more is required. According to a research published in May 2019 in the journal Proceedings of the National Academy of Sciences of the United States of America, the influence of regional precipitation patterns on four key crops viz., wheat, soybean, rice, and maize is expected to emerge by 2040. Climate change would cause portions of land used to produce these crops in certain nations to become permanently drier, while equivalent land portions in other countries would become permanently wetter. Land currently dedicated for wheat cultivation in India, for example, would get more precipitation between 2020 and 2060, under present trends in greenhouse gas emissions. According to the study, 100 percent of rice-growing area, 91 percent of maize-growing land, and 80 percent of soybean-growing land in India would encounter wetter circumstances in the next 40 years. Longer-term fluctuations in temperature and precipitation, as well as day-to-day weather variability will have a significant influence on food production in the next 50 to 100 years.

IMPACT OF CLIMATE CHANGE ON LIVESTOCK

Heat waves, which are expected to become more often as a result of climate change, may pose a direct threat to livestock. Heat stress can increase illness susceptibility, diminish fertility, and reduce milk production over time. Parasites and illnesses that harm livestock may become more common as a result of climate change. Some parasites and diseases may survive more readily due to the earlier start of spring and warmer winters. Moisture-dependent pathogens may grow in places where rainfall is higher. In response to climate-induced changes in pests, parasites, and microorganisms, potential modifications in veterinary practices, such as an increase in the use of pesticides and other animal health treatments, are expected to be implemented. This might raise the danger of pesticides entering the food chain or contribute to the evolution of pesticide resistance, with ramifications for livestock and aquaculture product safety, distribution, and consumption. Increased temperature with reduced feed quality and feed intake will result in lower milk production in high producing dairy cows and reduce meat production in ruminant caused by decreased body size. The reproduction capacity of cows, pigs and poultry will be observed with increasing temperature.

Carbon dioxide increase may enhance pasture productivity, but they may also reduce pasture quality. CO_2 levels in the atmosphere can boost the production of plants that animals eat. However, when CO_2 levels rise, the quality of some pastureland fodder diminishes. As a result, livestock would have to consume more food in order to achieve the same nutritional advantages. Drought could put pasture and feed supplies at risk. Drought lowers the amount of good fodder available to cattle grazing. Droughts might last longer and be more extreme in some places as a result of rising summer temperatures and less precipitation. Drought-related reductions in crop output might pose a concern for animals that rely on grain.

IMPACTS OF CLIMATE CHANGE ON FISHERIES

Researchers at National Oceanic and Atmospheric Administration reported that the oceans have warmed 0.12ºC per decade since 2000, nearly twice as fast as earlier estimates of 0.07ºC per decade. Rising water temperature causes coral bleaching and loss of breeding ground of marine fishes and mammals. Water temperatures in the lakes, freshwater streams and coastal surface waters are warming in many places around the world. The health of fish and their habitats are being impacted by the warmer seas. Many fish are temperature sensitive and can only survive in particular temperature ranges. As the water in oceans, streams, and lakes warms, fish seek cooler waters at higher latitudes or elevations, or at greater depths when possible. However, fish can only go so far north or so high in elevation before running out of water, much alone water in the right temperature zone. In addition, when the temperature rises, the composition of the water changes. For example, oxygen levels drop and algae blooms growth. This also cause migration of fish into new areas and such migration can put these species into competition with other species over food and other resources. Climate change has been connected to several outbreaks of marine diseases.

The oceans act as sink for the atmosphericCO_2 and rising CO_2 level is causing ocean acidification.

Carbonate, a fundamental building component of seawater, is depleted as a result of ocean acidification. This makes it more difficult for aquatic organisms to build shells and skeletons, such as coral and certain plankton, and existing shells may dissolve. Higher CO_2 concentrations in the water may benefit certain algae and sea grass by increasing their photosynthetic and growth rates. Other marine organisms, such as molluscs, corals, and some types of plankton, will be harmed by a more acidic environment. Ocean acidification also threatens the structures of sensitive ecosystems upon which some fish and shellfish rely.

POSSIBLE STRATEGIES TO REDUCE NEGATIVE IMPACT OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTION

With effective adaptation strategies, it is possible to reduce or even avoid some of the negative impacts of climate change on food production. The adaptation strategies mainly aim at activities which can reduce vulnerability and enhance resilience of the system to climate change. Some of the possible adaption strategies that can employ are listed below:

Crop management strategies:

- Switching to varieties tolerant to heat, drought or salinity
- Optimizing irrigation
- Managing soil nutrients and erosion
- Changes in sowing dates
- Nutrient management practices
- Conservation tillage practices

Livestock and fishery management strategies:

- Matching animal numbers to change in pastures
- More farms that mix crops and livestock
- Controlling the spread of pest, weed and diseases
- Switching to more abundant fish species
- Restoring degraded fish habitats and breeding sites like mangroves

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