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Impact of Global Warming on Agriculture

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Abstract

Global warming is caused by a blanket of pollution that traps the heat around the earth. This pollution has natural and anthropogenic factors. This pollution comes from automobiles, factories, power plants all of which burns fossil fuels. In the long list of potential problems from global warming, the risks to world agriculture stand out as among the most important. Quantity and quality of crops in terms of productivity, growth rates, shrinking of cropped area for winter crops, photosynthesis and transpiration rates, moisture availability etc. are major concern.

Keywords: Global Warming, Agriculture, Carbon dioxide, Pest, Flood, Land Degradation.

Increasing temperature

The average temperature of the planet has increased by 0.8º Celsius (33.4° Fahrenheit) compared to the end of the 19th century. Each of the last three decades has been warmer than all previous decades since the beginning of the statistical surveys in 1850.

At the pace of current CO_2 emissions, scientists expect an increase of between 1.5° and 5.3°C (34.7° to 41.5°F) in average temperature by 2100. If no action is taken, it would have harmful consequences to humanity and the biosphere.

Rising average temperatures, more extreme heat throughout the year, fewer sufficiently cool days during the winter, and more frequent cold-season thaws will likely affect farmers in all regions. Although, rising temperature will help agriculture to some extent in temperate region as area for agriculture will increase. For example, an increase in the temperature of the temperate climate zones of China has caused a significant increase in the rice yield and allowed a northward expansion of rice planting. Yet, Beyond a certain range of temperatures, warming tends to reduce yields because crops speed through their development, producing less grain in the process. And higher temperatures also interfere with the ability of plants to get and use moisture. The ranges of minimum and maximum temperatures are different for each crop species different stages of development, beyond which all processes of growth are inhibited. The reproductive stage (flowering and pollination) is the most sensitive stage of development to heat stress. Heat stress can significantly affect plant respiration, photosynthesis, stability of leaf membranes, quality of seeds and overall crop production.

Evaporation from the soil accelerates when temperatures rise and plants increase transpiration—that is, lose more moisture from their leaves. The combined effect is called "evapotranspiration." Because global warming is likely to increase rainfall, the net impact of higher temperatures on water availability is a race between higher evapotranspiration and higher precipitation. Typically, that race is won by higher evapotranspiration.

Effect of rising CO_2 level

Carbon dioxide is a perfect example of a change that could have both positive and negative effects. Carbon dioxide is expected to have positive physiological effects through increased photosynthesis. The impact is higher on C3 crops such as wheat and rice than on C4 plants like maize, sugarcane and grasses. The direct effects of changes in CO_2 concentration will be through changes in temperature, precipitation and radiation. However, indirect effects will bring changes in soil moisture and infestation by pests and diseases because of rising temperature and relative humidity. Such indirect effects through the increase in temperature will reduce crop duration, increase crop respiration rates, evapo-transpiration, decrease fertilizer use efficiency and enhance pest infestation. There is general consensus that the yield of main season (Kharif) crop will increase due to the effect of higher levels. However, large yield decreases are predicted for the rabi crops because of increased temperatures. The rising CO_2 level in atmosphere has indirect impact on insect population. Soybean crop in higher CO_2 concentration had 57% more insect damage (Japanese beetle, Leafhopper, Root worm, Mexican bean beetle) than earlier. It causes increase in level of simple sugars in the leaves that stimulates more feeding by insects. Increased C/N ratio in plant tissue due to increased CO_2 level may slow insect development and increase life stages of insect pests vulnerable to attack by parasitoids. At our current rate of green house emissions, several of the main pests that target corn will increase in number and expand their range by the end of 21st century.

Pest threat and weed proliferation

Crop losses for critical food grains will increase substantially as the climate warms, as rising temperatures increase the metabolic rate and population growth of insect pests. The losses will come from an increase in insect metabolism, and from faster insect population growth rates. The link with metabolism is straightforward .When the temperature increases, the insects' metabolism increases so they have to eat more.

"Temperate regions are not at that optimal temperature, so if the temperature increases there, populations will grow faster," said Merrill, an ecologist who studies plant-crop interactions. "But insects in the tropics are already close to their optimal temperature, so the populations will actually grow slower. It's just too hot for them."

The University of Illinois conducted studies to measure the effect of warmer temperatures on soybean plant growth and Japanese beetle populations. Warmer temperatures and elevated CO_2 levels were simulated for one field of soybeans, while the other was left as a control. These studies found that the soybeans with elevated CO_2 levels grew much faster and had higher yields, but attracted Japanese beetles at a significantly higher rate than the control field. The beetles in the field with increased CO_2 also laid more eggs on the soybean plants and had longer lifespan, indicating the possibility of a rapidly expanding population. If the project were to continue, the field with elevated CO_2 levels would eventually show lower yields than that of the control field.

When climate change leads to hotter weather, coupled with wetter conditions, this can result in more damaging locust swarms. Recent attacks of locust in north India and Pakistan has been another incident.

Weeds: The problem is projected to further aggravate with climate change as weeds can better adapt to temperature fluctuations than crop plants. Weeds, unlike crop plants, are sturdy and can grow in a wide range of climatic conditions and soil types. They produce an astounding number of seeds which are often light in weight and are carried by wind to near and far away destinations helping them to readily colonise a barren land or an already established field. Weeds are not only ecology destroyers but are a serious health hazard, too.

"In a climate change scenario, there will be difficulty in terms of untimely rains, hardy temperature conditions, and extremes of weather. In any case, weeds are hardier than crop plants, as while humans breed crops, nature breeds weeds. So, weeds will be more tolerant to any climate aberrations," explained Kapila S. Rathore, senior scientist at the Indian Agricultural Research Institute. While farmers use herbicides--chemicals to eliminate weeds-research suggests that the rise in the temperature can increase volatility of herbicides rendering them ineffective to act and kill the weeds. Adding to the plight of farmers is the problem of resistance caused by extended and overuse of herbicides.

Parthenium, which is popularly believed to have reached India along with wheat import during the famine of 1950s has not only covered roadsides and fields but also led to allergies in humans. Likewise, water hyacinth competes with marine organisms for nutrients and light and is a serious threat to the fishery industry.

Climate change and land degradation

Human activities — primarily burning of fossil fuels and changes in land cover — are modifying the concentration of atmospheric constituents or properties of the Earth's surface that absorb or scatter radiant energy .Climate change constitutes an additional pressure that could change or endanger ecosystems and the many goods and services they provide. Soil properties and processes — including organic matter decomposition, leaching and soil water regimes — will be influenced by temperature increase. Soil erosion and degradation are likely to aggravate the detrimental effects of a rise in air temperature on crop yields. Climate change may increase erosion in some regions, through heavy rainfall and through increased wind speed.

CO_2-induced climate change and land degradation remain inextricably linked because of feedbacks between land degradation and precipitation. Climate change might exacerbate land degradation through alteration of spatial and temporal patterns in temperature, rainfall, solar radiation, and winds. Several climate models suggest that future global warming may reduce soil moisture over large areas of semi-arid grassland in North America and Asia. This climate change is likely to exacerbate the degradation of semi-arid lands that will be caused by rapidly expanding human populations during the next decade. It is predicted that there will be a 17 per cent increase in the world area of desert land due to the climate change expected, with a doubling of atmospheric CO_2 content.

Rainfall is the most important climatic factor in determining areas at risk of land degradation and potential desertification. Rainfall plays a vital role in the development and distribution of plant life, but the variability and extremes of rainfall can lead to soil erosion and land degradation. If for a period of time, this land degradation can lead to desertification. The extremes of either too much or too little rainfall can produce soil erosion that can lead to land degradation .However, soil scientists consider rainfall the most important erosion factor among the many factors that cause soil erosion. Rainfall can erode soil by the force of raindrops, surface and subsurface run off, and river flooding.

The dry lands of the world are affected by moderate to severe land degradation from wind erosion and there is evidence that the frequency of sand storms/dust storms in increasing. It has been estimated that in the arid and semi-arid zones of the world, 24 percent of the cultivated land and 41 per cent of the pasture land are affected by moderate to severe land degradation from wind erosion. Wind erosion-induced damage includes direct damage to crops through the loss of plant tissue and reduced photosynthetic activity as a result of sandblasting, burial of seedlings under sand deposits, and loss of topsoil. The last process is particularly worrying since it potentially affects the soil resource base and hence crop productivity on a long-term basis, by removing the layer of soil that is inherently rich in nutrients and organic matter. Wind erosion on light sandy soils can provoke severe land degradation and sand deposits on young seedlings can affect crop establishment

Heavy rainfall and flooding

Food production can also be impacted by too much water. Heavy rainfall events leading to flooding can wipe out entire crops over wide areas, and excess water can also lead to other impacts including soil water logging, anaerobicity and reduced plant growth. Indirect impacts include delayed farming operations . Agricultural machinery may simply not be adapted to wet soil conditions.

The proportion of total rain falling in heavy rainfall events appears to be increasing, and this trend is expected to continue as the climate continues to warm. A doubling of CO_2 is projected to lead to an increase in intense rainfall. In the higher end projections, rainfall intensity increases by over 25 per cent in many areas important for agriculture.

Drought and desertification

There are a number of definitions of drought, which generally reflect different perspectives. It is common to distinguish between meteorological drought (broadly defined by low precipitation), agricultural drought (deficiency in soil moisture, increased plant water stress), hydrological drought (reduced stream flow) and socio-economic drought (balance of supply and demand of water to society. Drought causes significant yield reductions both for rainfed and irrigated crops. Drought can have impact on cropping areas and crop yield. The initial effect of drought on the plants is the poor germination and impaired seedling establishment finally leading to the crop yield.

Desertification is land degradation in arid, semi-arid, and dry sub-humid areas, collectively known as drylands, resulting from many factors, including human activities and climatic variations. The range and intensity of desertification have increased in some dryland areas over the past several decades. The highest numbers of people affected are in South and East Asia, the circum Sahara region including North Africa and the Middle East including the Arabian Peninsula. Desertification reduces the land's resilience to natural climate variability. Soil, vegetation, freshwater supplies soil, vegetation, freshwater supplies and other resources tend to be resilient. Soil becomes less productive -exposed and eroded exposed and eroded topsoil can be blown away by wind or washed away by rainstorms, Vegetation becomes damaged. Edible plant species may be lost and invasion of inedible plant species will be occurred when pastures are overgrazed.

Impact on coastal agriculture

Oceans cover approximately 72% of the surface of the Earth in total with 620,000 km of coastline. Climate change unquestionably poses complex challenges to coastal communities. Over 40% of the global population (around 2.4 billion people) reside in coastal areas or within 100 km from the coast, amid extremely productive deltas, coral reefs, mangrove biomes and the adjacent land-based estuaries. Many inhabitants of these environmentally heterogeneous regions embrace blended livelihoods based on natural resources, including agriculture and artisanal fishing. Coastal agriculture will face added impacts from sea-level rise (SLR), inundation, seawater intrusion, rising salinity, storm surges, tropical cyclones and flooding. A few stressors (e.g., floods, inundation and saltwater intrusion) are not directly climatic in nature but can be caused or accelerated by climate change. Coastal floods are caused by heavy rainfall, particularly when rainwater cannot discharge through the nearby rivers and creates water logging conditions. Coastal inundation occurs when coastal areas are submerged by a large amount of seawater brought by, for example, sea-level rise, tidal surges and cyclones. Coastal saltwater intrusion is a global issue that threatens soil productivity, and it is estimated that by 2050, salinity will affect 50% of all arable soil worldwide.

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