BREATHING EARTH: ESSAYS ON ENVIRONMENT

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GLOBAL WARMING AND ITS EFFECTS ON AGRICULTURE IN INDIA

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Agriculture is one of the main pillars of the Indian economy, accounting for more than 17-18% of the GDP of this country. More than 70% of Indians depend on agriculture for their livelihood.The main crops are wheat, maize, rice, millets, pulses, sugarcane and oil-seeds. Any decline in agricultural production in India can lead to rural distress as well as to high inflation also. In this sense, development of this country depends heavily on steady agricultural production. However, some serious concerns have appeared in the form of Global Warming and Climate Change, which have potentials to hold back the process of development in this country. Warming of the climate is a global phenomenon and it has already shown its devastating effect on the environment as well as on the human population in various configurations and scales. Significant changes already noted in climate and various factors have already imparted a marked impact on agriculture all over the world. These factors are increase in temperature, changed pattern of rainfall, intensity of extreme weather etc. India is also experiencing a significant impact of these factors on the Indian environment and particularly on Indian agriculture.

'Global Warming' and 'Climate Change' are two popular terms, which are in use most generally in any writing on environment related topics. Global warming refers to the phenomenon of increasing average surface temperature of the Earth over the past one or two centuries. (Mann M. E. 2009)

On the other hand, Climate change refers to change in the totality of attributes that define climate not only surface temperature, but also precipitation pattern, wind, ocean currents and other measures of the Earth's climate. Global warming is simply one of the attributes of Climate change. Climate change consists of two components, one is natural and the other is manmade. Global warming generally refers to the man made or anthropogenic component of climate change. The anthropogenic activities over the last fifty years have significantly increased the surface temperature contributing to Climate change too.

The average surface temperature of the Earth is maintained by a balance between incoming an outgoing sources of energy. The incoming source of energy is found in the form of solar radiation some of which is visible in the form of light. However, much of the radiation is invisible. 30 % o solar radiation goes back to space reflected by clouds, the reflective areas of Earth surface etc an the remaining 70% of the incoming source of energy is absorbed by the surface of the Earth an the atmosphere. They also emit the same amount of radiation that they receive from the sun, bac to space in the form of invisible infrared radiation. The surface temperature of the Earth depend upon this outgoing radiation. (Mann M. E. 2009)

GREENHOUSE EFFECT

Apart from this, the surface temperature becomes warmer by another factor also that is th 'Greenhouse' effect. Greenhouse gases such as Carbon dioxide; Methane, and nitrous oxide mak our world habitable.

Carbon dioxide (CO_2) is a minor but very important component of the atmosphere; carbon dioxid is released through natural processes such as respiration and volcano eruptions and through huma activities such as deforestation, land use changes, and burning fossil fuels. Methane is hydrocarbon gas. It is produced through both natural sources and human activities, including th decomposition of wastes in landfills, agriculture, and especially rice cultivation, as well a ruminant digestion and manure management associated with domestic livestock. It is a far mo active greenhouse gas than carbon dioxide. Nitrous oxide is a powerful greenhouse gas produce by soil cultivation practices, especially the use of commercial and organic fertilisers, fossil fue combustion, nitric acid production, and biomass burning.(Encyclopaedia Britannica,2023)

These Greenhouse gases absorb some of the infrared radiation produced by the earth. Therefo some parts of the outgoing infrared radiation remain in the earth's atmosphere. The Greenhou gases also emit the same amount of radiation that they have absorbed. Thus, they are responsib for increasing the amount of radiation downward toward the earth's surface. This in turn forc earth to emit more than 70% of radiation to maintain equilibrium. In the process, it also increas the surface temperature. This is an atmospheric or natural greenhouse effect. It results from t natural presence of Greenhouse gases in the atmosphere. However, another form of Greenho effect is human in nature. This man-made Greenhouse effect is primarily responsible f

pogenic Climate change. Human beings have been increasing Greenhouse gas concentration e form of Carbon dioxide and Methane through industrial activity. Fossil fuel burning for s and other purposes is also contributing toward anthropogenic climate change. Agricultural also increases concentration of Greenhouse gases. These human activities are also bringing te change. Under these situations, the Intergovernmental Panel on Climate Change (IPCC) that the global mean surface temperature will rise and may result in uneven climate . In its report IPCC has stated that the 'amount and rate of warming expected for the 21st depends on the total amount of greenhouse gases that mankind emits.' (Cicerone RJ, Nurse 9)

CTS OF GLOBAL WARMING

kinds of climate change due to anthropogenic impact on earth's climate have profoundly l agriculture all over the World in a variety of ways. Some parts of the world are ncing huge farm production loss due to powerful storms, some others facing crop loss due nged drought. Increase in temperature and precipitation has affected crop production dly. In fact, Climate change affects agriculture in a number of ways. It affects through temperature change, average rainfall change, climate extremes, changes in pests and , changes in nutritional quality of crops, change in atmospheric carbon dioxide and ground e concentration, and change in sea level.

y plant, there is an optimal temperature for vegetative growth, and with the increase or e in temperature, this growth gets adversely affected. Once the temperature goes beyond a nge it tends to reduce yields as crops speed through their development and for this reason, ge to produce less grain. Similarly, there is a range of temperatures at which a plant s seed. Outside of this range, the plant will not reproduce. Higher temperature badly affects ity of a plant to get and use moisture. With the rise in temperature, evaporation from the erates plants and increases transpiration; in the process, they lose more moisture from es. The combination of these two processes is known as 'Evapotranspiration'. Although warming increases rainfall, yet the evapotranspiration rate remains higher than the rate of ion. (Cline W. R.2007)For this reason plants in different parts of the world have reached um temperature tolerance level. Some of the corps' yield is falling sharply because of

small climate changes. Global warming has reached such a level that current agricultural pra
have become insufficient to support larger civilization.

Global warming is also responsible for an increase in insect population. As it extends
growing seasons for insects, the latter get additional breeding cycles leading to populatio
among insects. Every year under normal conditions, insects used to have two breeding season
under the influence of global warming, the insect population has grown rapidly. Warm we
conditions also increase the insect population due to the increase in Carbon dioxide l
Increased levels of Carbon dioxide bring a higher growth rate in plants. At the same time p
lose vital chemical defence against insects through deactivation of three major genes in p
which prevent insects from digesting plants. In the absence of this protein-based defence, in
can digest more plants, which in turn increase their lifespan besides increasing their ra
birth.(Leonard A.W, 2006). An experiment conducted on Japanese beetles has proved be
doubt that, under increased levels of Carbon dioxide, these insects enjoy longer lifespans and
rate of egg laying increases. This increase in pest insect population is very much harmful fo
yield of staple crops. (Crops, Beetles, and Carbon Dioxide)

One of the most important parameters of climate is rainfall. Rainfall is the major factor i
growth and production of food crops at both the germination and fruit development stage. Th
a direct relationship between rainfall and agriculture. Therefore, any change in rainfall pat
brings in change in cropping patterns as well. According to climate models, global warming c
change in rainfall patterns. This change may strengthen the current patterns of rainfall, and thu
wet regions get wetter and dry regions get drier. Because of global warming, warmer air
more water vapour, and this additional water vapour falls in the already wet parts of the
These changes in rainfall patterns directly affect agricultural production. Besides this, co
flooding also reduces the amount of land available for agriculture. As almost all crops are ra
dependent, farmers are finding it hard to cope with this effect of climate change.

EFFECTS OF GLOBAL WARMING IN INDIA

India has also experienced extreme weather events over the last four decades. A warming tren
been observed along the west coast, in central India, the interior peninsula, and north-eastern
Average annual temperature has risen by 0.48 degrees between 1970 and 2016. At regional l

variations have been recorded in different parts of India. During the same period, rainfall creased by 26 mm. A significant decreasing trend in rainfall was observed over parts of , Madhya Pradesh, Kerala and northeast India. At the same time some other parts of India th West India, north Andhra Pradesh have experienced an increasing trend of rainfall. Both trends have adversely affected agriculture in India. Along with these, trends of Extreme events have been observed in some parts of India. Frequent droughts have hit southern and parts of India. There has been an overall increasing trend in severe storm incidence along every year. While the states of West Bengal and Gujarat have reported increasing trends, has been observed in Orissa. There is also a trend of rising sea level. Using the records of tide gauges in the north Indian Ocean for more than 40 years, scientists have estimated that rise was between 1.06-1.75 mm per year. These rates are consistent with 1-2 mm per year sea level rise estimates of the IPCC.

alayas possess one of the largest resources of snow and ice and its glaciers form a source for the perennial rivers such as the Indus, the Ganga, and the Brahmaputra. Glacial melt ect their long-term lean-season flows, with adverse impacts on agriculture. Changes in key variables, namely temperature, and precipitation may have significant long-term ons for the quality and quantity of water. River systems of the Brahmaputra, the Ganga, Indus, which benefit from melting snow in the lean season, are likely to be particularly by the decrease in snow cover. Apart from this, due to rise in sea level, the fresh water near the coastal regions may suffer salt intrusion.

agricultural productivity is sensitive to two broad classes of climate-induced effects (1) ects from changes in temperature, precipitation or carbon dioxide concentrations, and (2) effects through changes in soil moisture and the distribution and frequency of infestation and diseases. Rice and Wheat yields could decline considerably with climatic changes 1996; 2001).

by Siddharth Hari, Partha Khare and Arvind Subramaniam has revealed the impact of shocks on agricultural productivity. Their study focused on how agricultural production in lar district change with the change of temperature and rainfall in that particular district. nd that in the short run, the highest possible temperature rise has lowered kharif yields by rrigated areas and in unirrigated areas by 13%. In the long run, the study suggests that

change in average temperature and rainfall will affect agricultural productivity. With the in in temperature, Indian farmers need to adapt with the changed conditions i.e. they have to c cropping technique, expand irrigation. Unless they do these adjustments, agricultural prod will fall by 12% in irrigated areas and by 18% in unirrigated areas. In the absence o adaptation by farmers, farm incomes will be lower by 20 to 25% on average in the coming especially in the unirrigated areas.(Hari Siddharth,Khare Parth& Subramanian Arvind,2018)

However, the vulnerability of agricultural production to climate change depends not only physiological response of the affected plant, but also on the ability of the affected socio-eco systems of production to cope with changes in yield, as well as with changes in the freque droughts or floods.

Unfortunately, in India, the adaptability of farmers with the changed condition is sev restricted by the heavy reliance on natural factors and the lack of complementary inputs institutional support systems. Agriculture in the coastal regions of Gujarat, Maharashtra, Karnataka is found to be the most negatively affected. Small losses are also indicated for the food-grain producing regions of Punjab, Haryana, and western Uttar Pradesh.

POSSIBLE MEASURES TO MEET THE CHALLENGES OF GLOBAL WARMING: order to withstand this kind of situation, it is crucial to develop policies to make agriculture resilient to changes in climate. Experts have suggested a number of measures to meet challenge, these are:

SPREADING IRRIGATION: There is an urgent need to spread irrigation. While signifi progress has been made over the past few decades, the proportion of cultivated land irrigation is less than 50% today – a lot remains to be done.

DEVELOPMENT IN AGRICULTURE TECHNOLOGY: Development in agricul technology needs to be stepped up. For this purpose, research in agricultural technology needs be promoted so that varieties in crops increase. There is also a need for developing such cropp techniques which are more resilient to the vagaries of weather.

RATIONALISATION OF THE USE OF WATER: Subsidies (power and fertiliser) that fav the indiscriminate use of water need to be rationalised and reduced, and support should instead

ded through non-distortionary forms such as direct transfers (as Telangana is attempting). More generally though, the cereal- and sugarcane-centricity of agricultural policy must be ved and overhauled.

tive agricultural practices and technologies can also play a role in climate change tion. This adaptation potential is more pronounced in developing countries where ltural productivity remains low; poverty, vulnerability and food insecurity remain high; and ect effects of climate change are harsh.

Lybbert and Daniel Sumner suggest six policy principles:

1. The best policy and institutional responses will enhance information flows, incentives and flexibility.
2. Policies and institutions that promote economic development and reduce poverty will often improve agricultural adaptation and may pave the way for more effective climate change mitigation through agriculture.
3. Business as usual among the world's poor is not adequate.
4. Existing technology options must be made more available and accessible without overlooking complementary capacity and investments.
5. Adaptation and mitigation in agriculture will require local responses, but effective policy responses must also reflect global impacts and inter-linkages.
6. Trade will play a critical role in both mitigation and adaptation, but will itself be shaped importantly by climate change.(Travis Lybbert and Daniel Sumner, 2012)

are five important ways to mitigate against this that the Indian government could start ng in now.

ART IRRIGATION

is a significant need for an appropriate irrigation system considering rising water scarcity pleting groundwater resources. Smart irrigation systems such as drip, sprinklers and water management should be made a priority and allocated across the country where

2. REDUCE POST-HARVEST LOSS

Post-harvest loss of major agricultural produce is estimated at US$13 billion . About 16% of and vegetables, valued at US$6 billion, were lost in the year 2015. Only 2.2% of fruits vegetables, the most perishable of agricultural products, are sorted and packed for consumpti India, increasing the chances of wastage as it gets sent abroad.

Small landholders lose out the most from this. It is not economically viable for most of the transport their produce for centralised large-scale processing – and they lack local processing preservation technologies. This results in a lot of wastage. This is then compounded by inade transport infrastructure – produce gets damaged on the journey because of bad roads, contaminated from repeated loading and unloaded, as well as lack of refrigeration.Small farms suffer from their reliance on middlemen to sell their product. As a result, they are some compelled to sell it at less than the cost of producing it. So there is an overwhelming nee develop technologies for local processing, smart packaging and transport facilities which do disadvantage small farmers.

3. DATA DRIVEN SUPPLY-CHAIN MANAGEMENT

India must start using data to continuously improve the efficiency of its agricultural supply cha New technologies such as sensors, GPS and satellite imaging can help collect meaningful dat make India's agriculture system more resilient. This enables different sections of the supply ch to monitor environmental and other conditions.

4. FARMER-CENTRIC CROP INSURANCE

To compensate for the uncertainty caused by climate change, an effective crop insura programme is required to protect farmers from bad yields. Many already pay into insura programmes but they provide little protection. The system needs overhauling so that small farm are protected by low premium and long-term insurance cover, instead of being designed, as seems to be at the moment, purely for the profit of insurance companies.

5. EVIDENCE BASED RESEARCH

Agricultural research will be vital in increasing yields but also in increasing resilience to all t problems that could come with climate change – including extreme heat and precipitation, pe

[redacted]p disease. Research will be especially important for crops such as pulses and soybean, [redacted] are crucial crops and highly vulnerable to weather and climate change. (Five ways India [redacted]lp its farmers face the threat of climate change, 2018)

[redacted]measures are expected to improve crop and water management practices. They are tailored [redacted] farmers and to the fragmented, small-scale agricultural landscape – to directly improve [redacted]cy, boost productivity and minimise the environmental impact on farming.

[redacted]LUSION

[redacted]clusion, it can be said that agriculture depends on temperature, be it crop production or [redacted]ction of plants, everything depends on the optimum range of temperature. Therefore, [redacted]s of temperature are surely going to affect agriculture and it will result in loss of crop [redacted]ion. Under this situation, it becomes imperative for every nation to keep anthropogenic [redacted]on the environment under control. The poor countries of the different parts of the world are [redacted]lnerable to this process. The IPCC third assessment report, published in 2001, concluded [redacted] poorest countries would be hit hardest by climate change. In 2014, in its report IPCC has [redacted] that the Climate change has reached a threshold of global warming beyond which current [redacted]ral practices can no longer support large human civilization.

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