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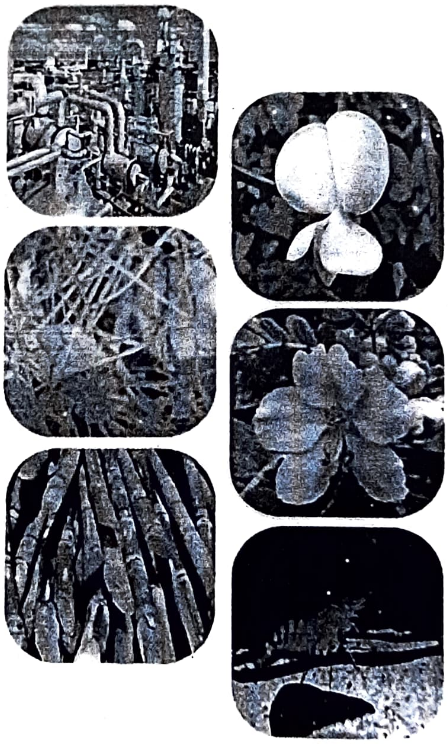

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EFFECT OF CLIMATE CHANGE ON INDIAN AGRICULTURE

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ABSTRACT:

Global climate change is a change in the long-term weather patterns that characterize the regions of the world. The term "weather" refers to the short-term (daily) changes in temperature, wind, and/or precipitation of a region. In the long run, the climatic change could affect agriculture in several ways such as quantity and quality of crops in terms of productivity, growth rates, photosynthesis and transpiration rates, moisture availability etc. Climate change is likely to directly impact food production across the globe. Agriculture is the backbone of Indian economy which in turn relies on the monsoon season. Rising global temperature is not only causing climate change but also contributing to the irregular rainfall patterns. Uneven rainfall patterns, increased temperature, elevated CO2 content in the atmosphere are important climatic parameters which affects the crop production. Research studies indicate that weathering parameters influence strongly (67%) compared to other factors like soil and nutrient management (33%) during the cropping season. The

Intergovernmental Panel on Climate Change (IPCC) projected that the global mean surface temperature will likely rise and may result into uneven climatic changes. This rising temperature may affect crop yield at large scale. It has been reported over 20th century that rising temperature plays an important role towards global warming as compared to precipitation. Researchers have confirmed that crop yield falls by 3% to 5% for every 1°F increase in the temperature. In India, crop production may be divided into two seasons: Kharif (influenced by south-west monsoon) and rabi (mostly influenced by north-east monsoon). Present study shows that the crop production is dependent on temperature. Temperature vs. crop production shows a funnel shape for all the seasons. For the lower temperature both the properties are almost linearly correlated. In rabi, at the beginning production show a negative trend with temperature which slowly converts to the positive trend. In kharif that negative trend is not visible. At higher temperatures production increases for both the seasons but with large scattering. The findings may be helpful to study the effect of climate change on the crop production.

KEY WORDS: Global Warming, Greenhouse Effect, climate change, Agriculture

INTRODUCTION:

Climate change is any significant long-term change in the expected patterns of average weather of region (or the whole Earth) over a significant period of time. It is about non-normal variations to the climate, and the effects of these variations on other parts of the Earth. These changes may take tens, hundreds or perhaps millions of year. But increased in anthropogenic activities such as industrialization, urbanization, deforestation, agriculture, change in land use pattern etc. leads to emission of green house gases due to which the rate of climate change is much faster. Climate change scenarios include higher temperatures, changes in precipitation, and higher atmospheric CO2 concentrations. There are three ways in which the Greenhouse Effect may be important for agriculture. First, increased atmospheric CO2 concentrations can have a direct effect on the growth rate of crop plants and weeds. Secondly, CO2-induced changes of climate may alter levels of temperature, rainfall and sunshine that can influence plant and animal productivity. Finally, rises in sea level may lead to loss of farmland by inundation and increasing salinity of groundwater in coastal areas.

OBJECTIVES – FOLLOWING ARE THE OBJECTIVES OF THIS STUDY

1. To discuss about Global climate change.
2. To discuss about Impact of climate change.
3. To discuss solutions for minimizing Global Warming.

RESEARCH METHODOLOGY

This is descriptive study based on secondary data. Various Research Journals, Books, Websites & various reports which is related to Global Warming were study to draw the conclusions.

RESULTS AND DISCUSSIONS

In this Paper Global climate change, Impact of climate change on Agriculture and Need for indigenous efforts in quantifying greenhouse gas (GHG) emission are discussed as follows.

Global climate change

The climate of earth is a dynamic one promoting the evolution of various living forms and changing the structure and chemical composition of the atmosphere. Over the past few decades, acceleration in the human-induced changes in the climate of the earth has become the focus of scientific and social scrutiny. The gaseous composition of the atmosphere has undergone a significant change mainly through increased industrial emissions, fossil fuel combustion, widespread deforestation and burning of biomass as well as changes in land use and land management practices. These anthropogenic activities have resulted in an increased emission of radiatively active gases, e.g., carbon dioxide (CO_2), methane (CH_3) and nitrous oxide (N_2O),popularly known as the 'greenhouse gases'. The atmospheric concentrations of carbon dioxide, methane and nitrous oxide were 280±6 ppm, 700±60 ppb and 270±10 ppb between the period 1000 and 1750 AD (IPCC, 2001. Climate change: Impacts, adaptation and vulnerability. Inter-Governmental Panel on Climate Change, Report of the Working Group II. Cambridge, UK.) Today, these values have become 369 ppm, 1750 ppb and 316 ppb, respectively. These greenhouse gases trap the outgoing infrared radiation from the earth's surface. The process, generally referred to as the greenhouse effect, adds to the net energy of the lower atmosphere and, therefore, results in atmospheric warming. The global mean annual temperature at the end of the 20th century has increased by 0.7 DC from that recorded at the end of the 19th century. Diurnal temperature range has also decreased, with night time temperature increasing at twice the rate of day time maximum temperature. The 1990s were, on an average, the warmest decade of the earth since the starting of instrumental measurement of temperature in 1860's, and the twentieth century has been the warmest during the last 1000 years. The seven warmest years globally in the instrumental record occurred in 1990s.

Global warming, in turn, leads to regional changes in climate-related parameters such as rainfall, soil moisture, and sea level. The extensive and frequent occurrence of climatic extremes such as droughts, heat and floods in the last decade in many parts of the world may be the fallout of this. The sea level has risen by 10-20 cm with regional variations (IPCC 2001). Similarly, snow cover is also believed to be gradually decreasing.

The Inter-Governmental Panel on Climatic Change of the United Nations in its report for 2001 has projected using different models that the globally averaged temperature of the air above the earth's surface might rise by 1.4-5.8°C over the next 100 years (Fig. 1) (IPCC 2001). The CO_2 levels are projected to increase to 388-39C to 478-1099 by 2100 using different models. For India, the area-averaged annual mean warming by 2020 is projected to be between 1.0 and 1.4°C and between 2.2 to 2.9°C by 2050. Relatively, the increase in temperature would be less in kharif (monsoon season) than in rabi (winter season). Thekharif rainfall is expected to increase in most places whereas rabi rainfall may decrease in some areas. The rabi rainfall will, however, have larger uncertainty (Table 1)

Table 1. Projected change in temperature and rainfall due to global warming in different crop seasons in 2020, 2050 and 2080s in south Asia.

Year	Season	Increase in temperature, °C		Change in rainfall, %	
		Lowest	Highest	Lowest	Highest
2020	*Rabi*	1.08	1.54	-1.95	4.36
	Kharif	0.87	1.12	1.81	5.10
2050	*Rabi*	2.54	3.18	-9.22	3.82
	Kharif	1.81	2.37	7.18	10.52
2080	*Rabi*	4.14	6.31	-24.83	4.50
	Kharif	2.91	4.62	10.10	15.18

IMPACT OF CLIMATE CHANGE

More floods, frequent droughts and forest fires, decrease in agricultural and aquacultural productivity, displacement of coastal dwellers by sea level rise and intense tropical cyclones, and the degradation of mangroves may be some of the likely consequences of climate change in Asia.

Such consequences could considerably affect the food supply and access through their direct and indirect effects on crops, soils, livestock, fisheries and pests. Increase in atmospheric CO_2 promotes the growth and productivity (photosynthetic activity) of plants. On the other hand increase in temperature, can reduce crop duration, increase crop respiration rates, affect the equilibrium between crops and pests, hasten nutrient mineralisation in soils, decrease fertiliser use efficiencies, and increase evapo-transpiration among others. Uncertainty in precipitation causing droughts and floods has been responsible for many famines, rural poverty and migration despite development of impressive irrigation potentials. These environmental changes, particularly temperature increase and sea level rise, could also affect fisheries directly and indirectly through changes in the availability of feed.

Similarly, by increased temperatures the changes in fodder and water availability may affect production of meat and milk. Indirectly, there may be considerable impact on agricultural land use due to snow melt, availability of irrigation, frequency and intensity of inter- and intra-seasonal droughts and floods, soil organic matter transformations, soil erosion, decline in arable areas (due to submergence of coastal lands), and availability of energy. All these changes would have tremendous impact on agricultural production and, hence, on the food security of any region. Several important socio-economic determinants of food supply such as government policies, capital availability, prices and returns, infrastructure, land reforms, and international trade are also expected to be influenced and altered by environmental changes.

NEED FOR INDIGENOUS EFFORTS IN QUANTIFYING GREENHOUSE GAS (GHG) EMISSION

Alarmed by the possible impact of global climatic change on the quality of life of human beings, there has been a serious concern all over the world in understanding the processes and developing strategies to mitigate the negative effects. It has been realized by all that a change in environmental quality affects all aspects of life. Efforts are, therefore, needed to reduce the emission of greenhouse gases, which are mainly responsible for atmospheric warms.

The solution to such environmental issues is closely linked with the issues of socio-economic problems. Each country or region addresses the problem with their own individualistic perception on what is best suited for their economic development and not necessarily what is best for the health of the world as a whole. Therefore, such environmental problems generally involve conflicts between the interests of those who benefit greatly and those who benefit less or none at all. For example, the quest for maintaining the currently unsustainable life styles by the western world prevents it from reducing energy consumption contributing to increased emissions of green house gases. On the other hand, the quest for improved income and quality of life by the developing countries forces them to increase their energy use.

The emissions of GHGs can be somewhat reduced by using cleaner technologies currently available in the western world. Such clean technologies can help the developing world in containing their GHG emissions and yet meet their developmental goals. However, the business interests of corporate bodies, who own such technologies, restrict their free sharing. Ironically, India, China and other developing countries of Asia have been blamed by the western world for their 'large' contributions to GHG emissions and thus global warming.

The total annual injection of methane into the atmosphere from all sources in the world is estimated to be 375 Tg (1 Tg = 1012 g or 1 million tonnes). Although the increase in annual load of methane in the atmosphere is much less than that of CO2, its high impaired absorption amounts to higher contribution (15-20%) in the global warming. Agriculture, largely rice paddies, and ruminant animal production, is considered a major source of this emission. Continuously flooded rice fields emit methane as anoxic conditions favour methanogenesis. International studies based on very limited measurements done in the USA and Europe and extrapolated to the whole world indicated that as much as 110 Tg per year was released from rice paddies alone (Houghton, J.T., Jenkins, G.J., and Ephraums, J.J. 1990, Climate Change. IPCC scientific assessment. Cambridge University Press). Since India and China are the major rice cultivators, US-EPA attributed 38 Tg methane per year to Indian rice fields. Based on this, the international opinion was built that Asia, in particular India and China, contributes considerably to global warming and should do something to prevent this.

It required sustained and systematic indigenous research effort to develop correct estimates of methane emissions form Indian paddies. The pioneering studies done in this context at the Indian Agricultural Research Institute since 1990 helped in rationalizing the estimates of GHG emissions and formulating our national policy on global climate change.

International concerns and conflicts on global climate change have now led to the United Nations Framework Convention on Climate Change (UNFCCC) following the Earth's Summit in June 1992. The UNFCCC, which came into force on 21st March 1994, requires all parties to compile, periodically update, and publish national inventories of GHG emission and sinks using comparable methodologies that have been agreed upon by the Conference of Parties (COP). The Indian Agricultural Research Institute (IARI) has taken a lead role in the preparation of the national inventories for methane and nitrous oxide emissions from Indian agriculture. The Institute has also been actively engaged in research to understand the greenhouse gas emission mechanisms in detail and to reduce the uncertainties in the greenhouse gas emission estimates, leading to the development of strategies to reduce the emissions. Following are the highlights of the work done in this regard.

METHANE EMISSION FROM RICE FIELDS

Methanogenesis, the process responsible for methane formation, occurs in all anaerobic environments in which organic matter undergoes decomposition. Rice is generally grown in waterlogged condition, which creates an anoxic environment and is conducive to methane production by the strictly anaerobic methanogenic bacteria. Methanogens use organic compounds as electron donors for energy and synthesis of cellular constituents and, in turn, reduce C to CH4 Field and laboratory experiments were conducted at IARI to

(a) Measure methane emission from rice ecosystems,

(b) Evaluate the effect of irrigation and fertilizer management on methane.

CONCLUSION

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 globe. Present study shows that the crop production depends on temperature. Funnel–like structure is observed for overall production (including rabi and kharif) which signifies their dependency on temperature. At low temperature, tail portion was observed in rabi (wheat) production whereas not in kharif (rice). This shows that rabi production has affected comparatively more than kharif at lower temperature. At high temperature range, both types of production shows increasing trend. Moreover, in case of high temperature, it has been observed that scattering in production gets increases. Our study confirms the report of IPCC which states that crop production will get affected at high temperature. Hence, temperature can be one of the significant parameter in crop production studies. At high temperature, prediction of crop production may become difficult as the data points got more scatter. If anyhow, such predictions can be improved further then it may help farmers to make their field planning better, identification of appropriate crop type in particular field, estimation of crop yield and requirement of water for irrigation. In this way, damage to the crops can be minimized and better enhancement in the crop yield can be achieved. Hence, government needs to adopt such predictions and accordingly reframe their plans and policies which may help agriculture sector to uplift and hence can strengthen our economy. Predictions can be improved further by doing long term analysis as the present study contains data of only 23 years. Present study may be limited to the monsoon dominated region. Similar studies may be done for other regions as well to gain the confidence.

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