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CLIMATE CHANGE AND FOOD SECURITY

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Introduction

Earth's environment has been habitable for millions of forms of life including human beings, allows us to grow the food we need to survive, function and develop. For centuries we have taken Earth's gifts for granted. But global reviews carried out in 2021 have raised serious concerns about the sustainability of both climate and food security.

In November 2021, 197 countries participated in the 26th Conference of Parties (CoP 26) held in Glasgow, Scotland. COP 26 reviewed the data on the current scenario of greenhouse gas emissions (GHG) and global warming. Currently, the average global temperature is 1.1° C higher than the 1850-1900 average. If the current trend in global warming is not halted, the figure may soon cross the 2° C threshold. This will put over 1 billion people under extreme heat stress; bleach over 99% of coral reefs; intensify the melting of sea ice in summer by 10 times, leading to a more rapid rise in sea levels and double the rate of extinction of plant species. This will endanger biodiversity, dietary diversity and food security, especially among the low- and middle-income countries and the poorer segments of the population in all countries. The Glasgow COP 26 pact set the goal of limiting global warming to 1.5° C, but the national commitments received thus far are not adequate to ensure progress towards this goal. The Glasgow Climate Pact requests that countries "revisit and strengthen" their climate pledges by the end of 2022, reduce greenhouse gas emissions as rapidly as possible, bring about changes in political, social, and economic priorities of governments to refocus on new, ambitious plans for GHG reduction before COP 27.

FAOs State of Food Security and Nutrition Report 2021 showed that after remaining virtually unchanged for five years, the prevalence of undernourishment (PoU) increased by 1.5% in 2020; this was in part due to the impact of the COVID 19 pandemic. In 2020, between 720 and 811 million people in the world faced hunger. Since 2014, there has been a rise in the prevalence of moderate or severe food insecurity measured by the Food Insecurity Experience Scale (FIES). The estimated increase in food insecurity in 2020 was equal to that of the previous five years combined. In 2020, one-third of the world population (2.4 billion) did not have access to adequate food, and 12% (928 million) faced severe food insecurity. Shifting to predominantly plant-based diets, which are healthy, economically and ecologically sustainable, can contribute to reducing the global burden of over-nutrition and non-communicable diseases. Even though global food production can meet this requirement, over 3 billion persons cannot access healthy diets, due to wastage of food stuffs, high cost of food and income inequalities. Current projections confirm that unless effective steps are taken to improve food production and diversity and address inequality in access to food, the SDG target of zero hunger will not be achieved by 2030.

Many citizens are troubled by the questions: Did our acts of commission and omission over decades damage the environment so badly that our children may inherit an unliveable earth? Why and how did we allow the deterioration in food security to reach current levels? How do we reduce GHG emissions, minimize global

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Fig 1 GHG drivers of climate change

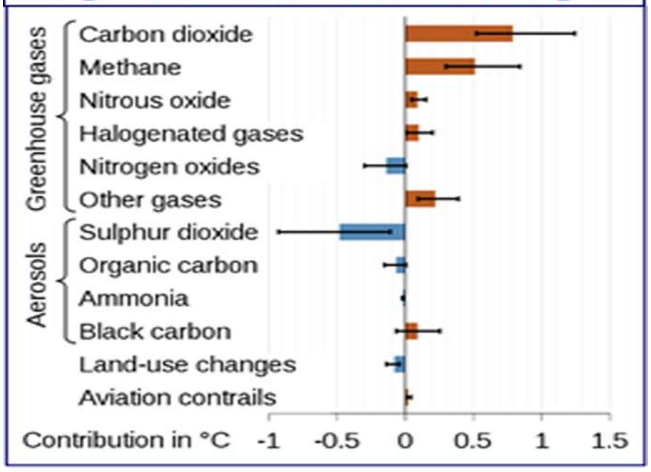
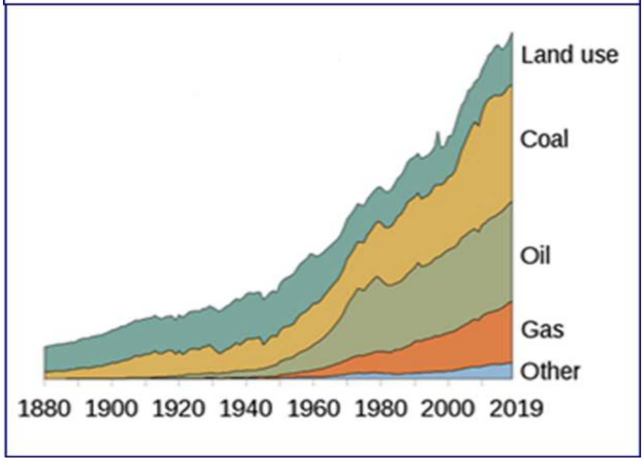


Fig 2 Carbon dioxide emissions by source since 1880



warming and cope with the myriads of adverse consequences of global warming, improve food security, and attain optimal nutrition and health in the coming decades? This article reviews the data on current magnitude and future projections about climate change and food insecurity at global and national levels and interventions to reduce global warming and mitigate its adverse impact on food security.

Earth's climate system

The mechanics of the earth's climate system are simple. When energy from the sun is reflected off the earth and back into space (mostly by clouds and ice), or when the earth's atmosphere releases energy, the planet cools. When the earth absorbs the sun's energy, or when atmospheric gases prevent heat released by the earth from radiating into space (the greenhouse effect), the planet warms. A variety of factors, both natural and human, can influence the earth's climate system. Over millennia GHG have played an important role in keeping the planet warm and habitable. The earth has gone through warming and cooling phases in the past; forces that had contributed to climate change in the earlier millennia include the spikes in intensity of solar emissions, volcanic eruptions and changes in naturally occurring greenhouse gas concentrations. Human beings have evolved and inhabited the earth for a relatively short period in its history, but have brought about enormous changes in earth and its atmosphere; taking cognisance of this, the current geological era has been named the Anthropocene era. Compared with the pace of change in earlier millennia, the changes in global environment and GHG emissions in the post 1850 (Industrial Revolution) period were substantial. The changes in GHG emissions and consequent global warming since the mid-20th century were on a higher scale, rapid, and unsustainable.

Factors associated with global warming

Greenhouse gas emissions

Carbon dioxide (CO2), methane (CH4), oxides of nitrogen, and halogenated gases are major GHG (Fig 1). All major spheres of human economic activity generate GHG. Burning of coal, oils and gas is the major source of CO2 emission (Fig 2). GHG emissions in relation to different economic sectors is shown in Fig 3. GHG emission during electricity generation led the steep rise in GHG in the last few decades; transport and heating systems using fossil fuels also contributed to the rise in global GHG emissions. The manufacturing industry (cement, iron, steel, electronics, plastics and clothes) contributed to GHG both through direct emissions from burning of fossil fuel and indirectly through use of electricity. Building construction and road construction cause GHG emission; both can

Fig 3 Greenhouse emissions by economic sector

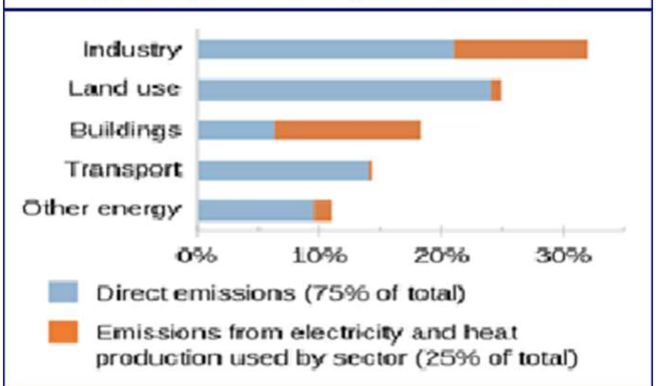


Fig 4 Global energy consumption, 2000 to 2019

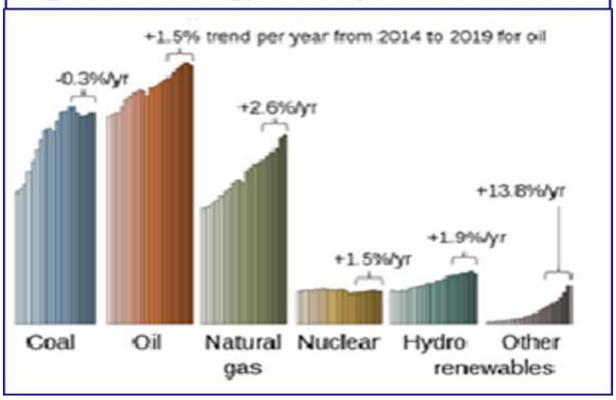


Fig 5 Total fossil fuel CO_2 emissions, 2000 to 2019

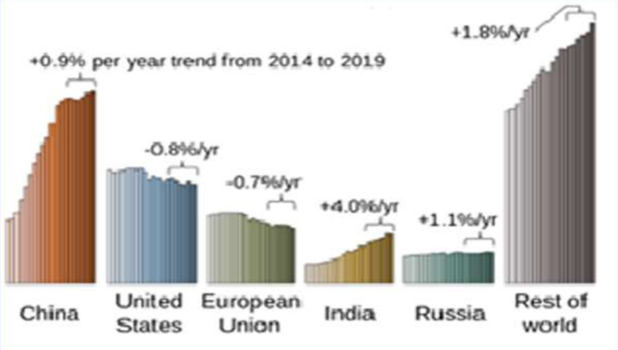
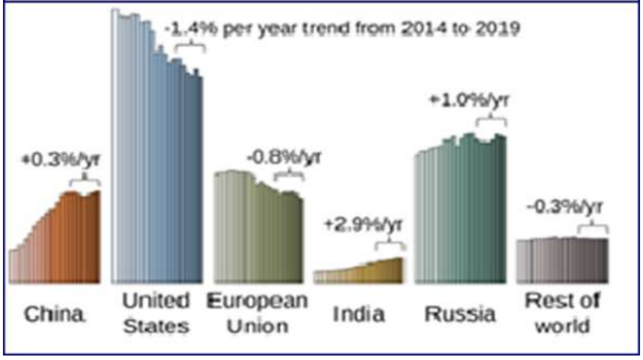


Fig 6 Per capita fossil CO_2 emissions, 2000 to 2019



change the reflectivity of the earth's surface, leading to local warming. GHG emissions related to land use were predominantly due to agriculture and agricultural waste. Nitrogenous fertilizers generate nitrous oxide; agricultural waste emits methane. Livestock farming (cattle, buffalo, sheep, and goats) especially on a commercial scale generates methane. Human activity also generates several aerosols which cool the earth. But these are produced in small quantities as compared to GHG and have a negligible impact on global temperature (Fig 1).

Global energy consumption and GHG emissions

Changes in global energy consumption between 2000 and 2019 are shown in Fig 4. In 2019, global GHG emissions continued to rise at a rate of 1.1%, reaching 52.4 Gt CO2 eq. CO2; emission from fossil fuel constitutes 73% of GHG; contribution of methane (19%), N2O (5%) and fluorine gases (3%) are far lower. GHG emissions in 2019 were about 59% higher than in 1990 and 44% higher than in 2000. In 2020, GHG concentrations reached new high: CO2 413.2 ppm, methane 1889 ppb and N_2O 333.2 ppb; these are, 149%, 262% and 123% of pre-industrial (1750) levels. The increase has continued in 2021. Contribution of nuclear, hydroelectric and renewable sources of energy to total energy consumption remains very low (Fig 4).

The GHG emissions that cause global warming come from every country in the world. Ten countries were major contributors to GHG emission in the past; now they contribute 68% of GHG emissions (Figs 5 & 6). They have a greater responsibility to reduce their GHG emissions steeply and to assist developing countries in their attempts to limit GHG emissions. Only 3% of total emissions come from 100 developing countries. They have to balance the need to accelerate the pace of development and economic growth in their countries with the global need to limit GHG emissions (Figs 5 & 6).

Between 1870 and 2019, India's contribution has been only 4 % of the global total GHG. There has been some increase in the CO2 emissions in the last decade in India when the country was striving to accelerate economic growth. In 2019, India was the third in terms of global GHG emission at 2.88 CO2 Gt but emission by China (10.6 Gt) and the United States (15 Gt) were far higher. India's per capita CO2 emissions is only 2.98 tonnes annually (Fig 5 and 6). India has set an emission target of 2.31 tonnes per capita by 2030 which is far lower than 2030 emission targets for US (9.42), China (8.88), EU (4.12) and UK (2.7) for 2030.

In the 26th Conference of Parties (CoP 26), India had committed to achieving the following targets:

- increase its non-fossil energy capacity to 500 gigawatts (GW) by 2030,
- meet 50% of its energy requirements from renewable energy by 2030,

Fig 7 Global mean temperature difference from 1850-1900 (°C)

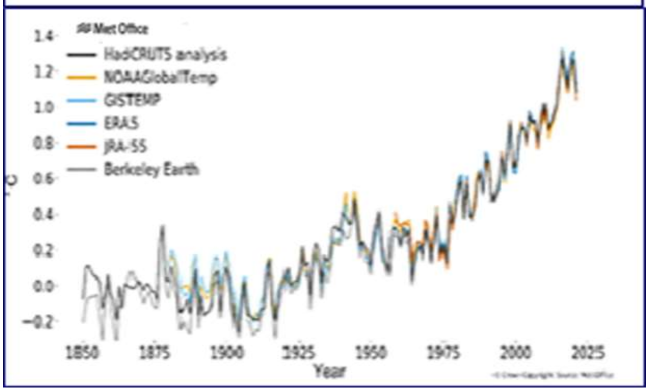


Fig 8 Global surface temperature

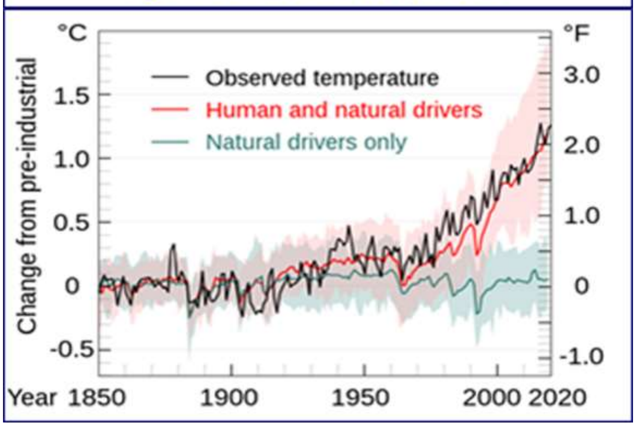
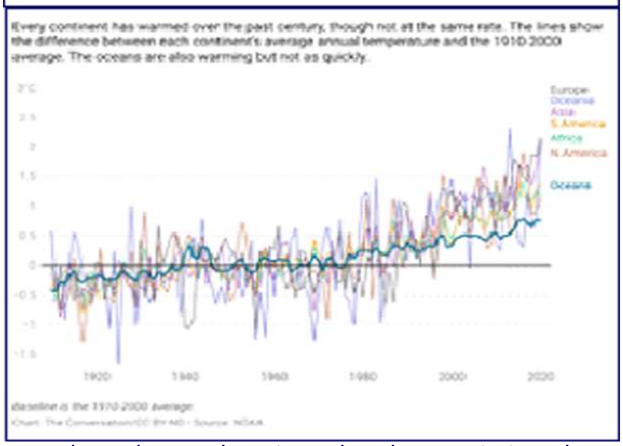


Fig 9 Rise in temperature over time in continents of the world



- reduce the total projected carbon emissions by one billion tonnes from now onwards till 2030
- reduce the carbon intensity of its economy by 45% by 2030,
- achieve the target of Net Zero emissions by 2070.

Climate change and global warming

Global warming is one of the most observable and widely measured manifestations of anthropogenic climate change. Earth-orbiting satellites, remote meteorological stations, and ocean buoys are used to monitor weather and climate. Scientists feed these data into sophisticated Earth Modelling System (EMS) and make projections on future climate changes. There has been a steep increase in the global surface temperature between 1850 and 2020 (Fig 7); the rise in global temperature is driven by the rise in GHG emissions (Fig 8). The contribution of the natural drivers of the global temperature have not changed between 1850 and 2020.

There has been an unprecedented increase in ambient temperature (global warming) across all continents in the last five decades (Fig 9). Though rise in temperature was universal, the magnitude of the rise in temperature varied in different regions and continents (Fig 10). As a result, the consequences of climate change vary substantially between regions. The World Meteorological Office (WMO) analyses and reports trends in global warming.

Fig 11 Global tree cover: annual loss

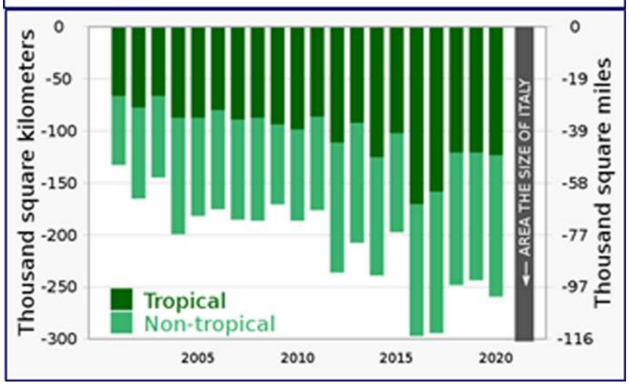
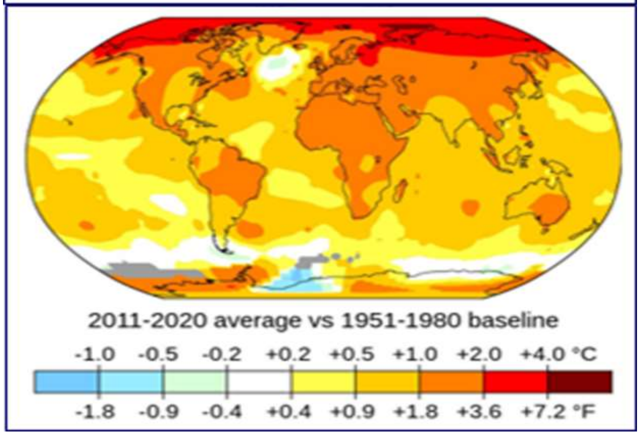


Fig 10 Temperature change in the last 50 years



The past seven years have been the seven warmest on record. In the first nine months of 2021 the global mean temperature for 2021 was about 1.09°C above the 1850-1900 average. In 2018, scientists emphasised that it was essential to limit global temperature rise to 1.5°C to avoid severe adverse consequences of global warming and maintain a liveable global climate. If there is no major effort to curtail the emissions, the rise in temperature will continue and in the worst-case scenario the rise in temperature by 2100 may be as high as 4°C. A temperature rise of this magnitude will have a really disastrous impact on all aspects of human activity and cause steep deterioration in the quality of life.

CO2 partitioning

Global forests absorb greenhouse gases from the atmosphere for photosynthesis; but these natural carbon sinks are unable to keep up with rising emissions. Cutting down forests for roads and factories, causes GHG emissions. When trees are cut, they release the carbon they have been storing. Deforestation and loss of forest cover are therefore major factors in increase in GHG emissions (Fig 11). It is estimated that logging, clear cutting, fires and other forms of forest degradation release an average of 8.1 billion metric tons of carbon dioxide per year accounting for more than 20% of all global CO_2 emissions. The ocean and the land (mostly trees) act as 'sinks' and absorb substantial proportions of

Fig 12 Carbon dioxide partitioning (Gt/yr)

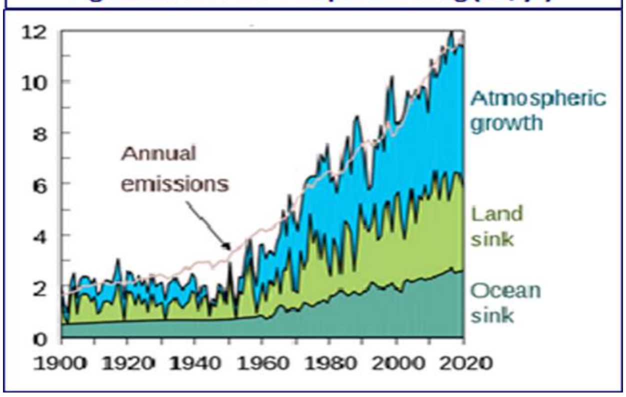


Fig 13 Precipitation anomaly Jan-Sep 2021

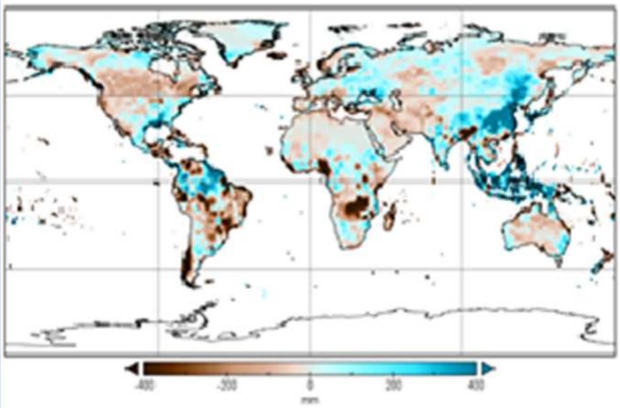
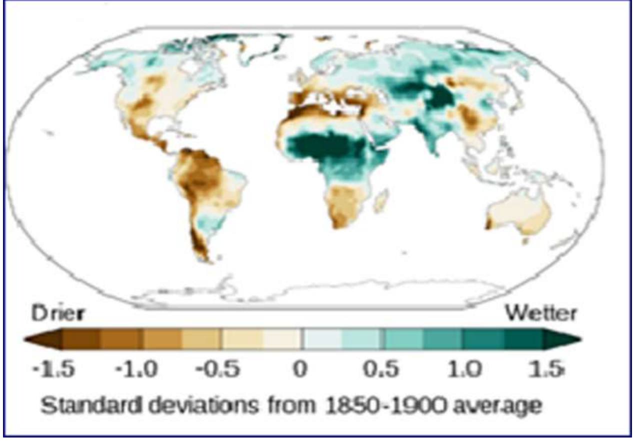


Fig 14 Soil moisture change at 2.0°C (3.6°F)



CO_2 emissions. Increasing deforestation will adversely affect the land sink for CO_2 emission. The part of the CO_2 not absorbed by the land and sea accumulates in the atmosphere and this results in a rise in atmospheric CO_2 (Fig 12).

Interventions to reduce GHG emission

One of the major problems is that the current high GHG concentration in the earth's biosphere will persist for several decades. Even if heroic efforts are made and the increase in emissions rate are halted, CO_2 concentration and global temperatures will remain high. Three broad categories of action are required on global level: cut emissions, adapt to climate change and evolve steps to mitigate its adverse impact. Each of these actions requires investments in technological innovations, human and financial resources. In order to cut emissions, it is imperative to move away from fossil fuels and towards eco-friendly sustainable energy sources like solar, wind and nuclear energy. Available technologies have to be shared freely and countries supported with financial assistance. R&D efforts to develop newer technologies have to be strengthened. While developing countries do have the human resources for undertaking the task, investment in technology development and financial resources to use them have to come predominantly from the developed countries. The extent to which developing countries achieve developmental transition and control of GHG emissions will determine their ability to lift millions out of poverty and food insecurity and help the world to reach a liveable climate.

Impact of global warming

All earth systems are closely inter-connected. Global warming is transforming all global ecosystems: the air we breathe, water we drink, the food we eat and the places where we live and work. Scientists have made projections regarding impact of GHG emission and global warming on different aspects of human activity taking into account drivers of greenhouse gas emissions, such as demographic change (including patterns of change), economic development, and technological development using the Earth Modelling System. Projections cover the magnitude and severity of a whole range of systems including:

- melting polar ice, rising sea level, and water scarcity,
- agro-eco-system and food production,
- extreme weather events such as flooding, storms, cyclones and avalanches and mud slides,
- food security, food borne infection, food contaminants, nutrition and health.

These projections are utilised for planning strategies and programmes for mitigation of the adverse consequences.

Global mean sea level changes primarily result from ocean warming via thermal expansion of sea water and land ice melt. The Arctic is heating up twice as fast as any other place on the planet. The mean global mean sea level rise was 2.1 mm per year between 1993 and 2002 and 4.4 mm per year between 2013 and 2021. Rising oceans threaten coastal ecosystems and low-lying areas including some islands; some of the world's largest cities, including New York City, Miami, Mumbai and Sydney, are at risk of partial submersion. Increasing salinity in coastal areas may have an adverse impact on food production. The ocean absorbs around 23% of the annual CO_2 emissions and is becoming more acidic. The ocean pH is decreasing at an unprecedented rate; with decrease in pH, the ocean's capacity to absorb CO_2 from the atmosphere is reduced and is aggravating global warming. Increasing salinity in coastal areas may have an adverse impact on food production.

Climate change affects precipitation (Fig 13), leading to scarcity of fresh water. Precipitation run-off and snow/ice melt have an impact on hydrological systems, water quality, water temperature and groundwater recharge. In many regions of the world, increased water scarcity under climate change may lead to soil moisture change especially if the rise in temperature is beyond 1.5°C (Fig 14). Both water scarcity and low soil moisture will present major challenges for food production.

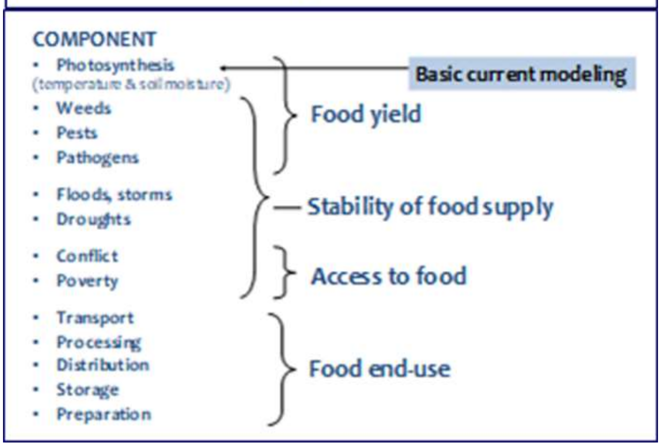
Climate change brings a cascade of direct and indirect changes in agro-ecosystems which adversely affect food production. Direct impact is through modification of physical characteristics such as temperature levels and rainfall distribution on specific agricultural production systems. Indirect effects are those that affect production through changes on other species such as pollinators, pests, disease vectors and invasive species, agricultural production, incomes and trade.

Current projections indicate that crop production will be consistently and negatively affected by climate change in low-latitude countries while climate change may have positive or negative effects in northern latitudes. Although some high-latitude regions may become climatically more suitable for crops, soil quality and water availability might become constraints to sustained increases in agricultural production in these regions. A recent multi-model projection using IPCC's highest scenario of warming found that by 2050 the yield of coarse grains, oil seeds, wheat and rice (70% of global crop harvested area) might be reduced by 17%.

Increased temperatures and reduced precipitation can cause substantial reduction in fodder and feed crops; these result in reduction in animal productivity and lower yields. In the past few decades severe drought had led to 20% to 60% losses in animals in sub-Saharan Africa; 10% to 25% reduction in dairy yields have been reported during severe drought in South Africa.

Climate change contributes to decreased productivity of forests. Trees die from drought, temperature stress, increased wind, water erosion, storm damage, forest fires, pest and disease outbreaks, landslides and avalanches, inundation and flood damage, saltwater intrusion and sea level rise. All these reduce the

Fig 15 Climate sensitive elements of the food system



contribution of forests to food production. It is estimated that 1.6 billion people fully or partly depend on forest produce for their livelihoods; their income and food security will be adversely affected.

Climate change affects capture fisheries and the development of aquaculture in marine and freshwater environments. Atmospheric warming and associated physical (sea and inland water surface temperature, ocean circulation, waves and storm systems) and chemical changes (salinity content, oxygen concentration and acidification) of the aquatic environment will result in reduction in fish catch. Increased coral reef bleaching threatens habitats of one out of four marine species. Many fish species are migrating poleward, resulting in the rapid "tropicalization" of mid- and high-latitude systems. These might lead to 40% decrease in fish catch in tropics and 30-70% increase in fish catch in high-latitude regions. Availability and diversity of riverine fish may decrease especially during dry seasons.

Adaptation of agriculture system to climate change

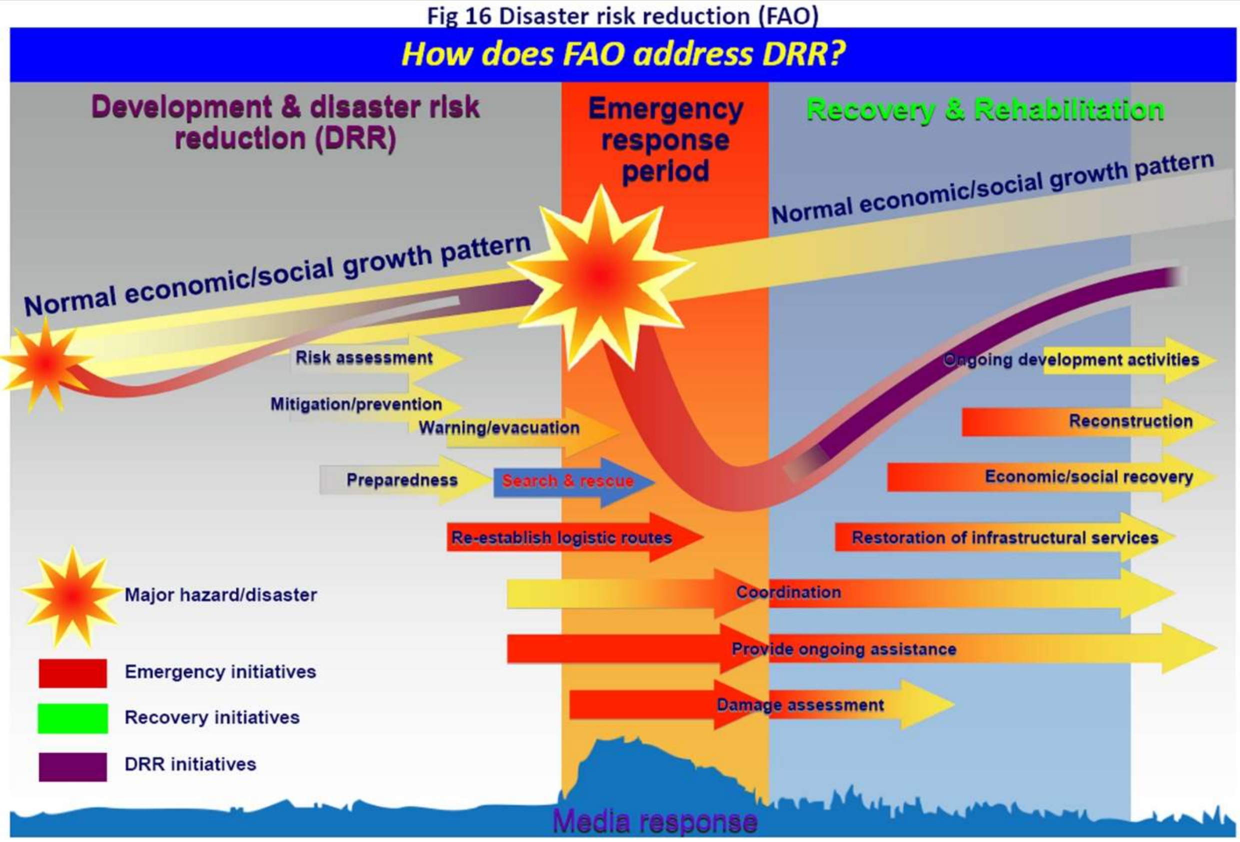
Climate change sensitive elements in food system are indicated in Fig 15. In the past agriculture had adapted to climate change – as seen by the existing agricultural diversity. It can therefore be expected to adapt to ongoing climate change also. However, the current climate change is posing a greater challenge because:

- increase in GHG emission is relatively steep and sustained,
- agriculture has changed its orientation from subsistence to market, and
- population is growing and demanding dietary diversity.

Water is a scarce resource; adaptation to improve water availability will include water harvesting and storage, access to irrigation, improved irrigation technologies, as well as agronomic practices such as minimum tillage and increase in soil carbon and organic matter which enhance soil water retention. Other practices for minimizing climate change associated risks include forest fire management, reduced logging, limiting of gathering of non-wood forest products or livestock grazing in forests, and restoring degraded forests to healthy sustainable levels.

Building up a resilient diversified agricultural system better equipped to cope with the stress of global warming, recover from damage and adapt to changes should receive high priority. Adaptation measures for crops can include the use of adapted varieties or breeds, with different environmental optima and/or broader environmental tolerances, diversification of varieties or crops as a method to hedge against risk of individual crop failure and integrated pest management and disease

Fig 16 Disaster risk reduction (FAO)



Mainstreaming DRR into ongoing development processes

control. Improvement in post-harvest practices, aimed at reducing wastage and increasing shelf life of the food stuff will help.

Market development and better linkages of smallholder and family farmers to domestic, national and regional markets are important to support adaptation actions, to enable food producers to get the inputs needed and to sell new products from diversification. Developing these market linkages also requires investment in small- and medium-size food processing units, small-scale traders at the retail and large traders at wholesale levels. National policies will be needed to reduce financial risks especially those related to price volatility. Policies will also be needed to lower transaction costs, facilitate monetary transactions, enable access to financial services and facilitate long-term investments.

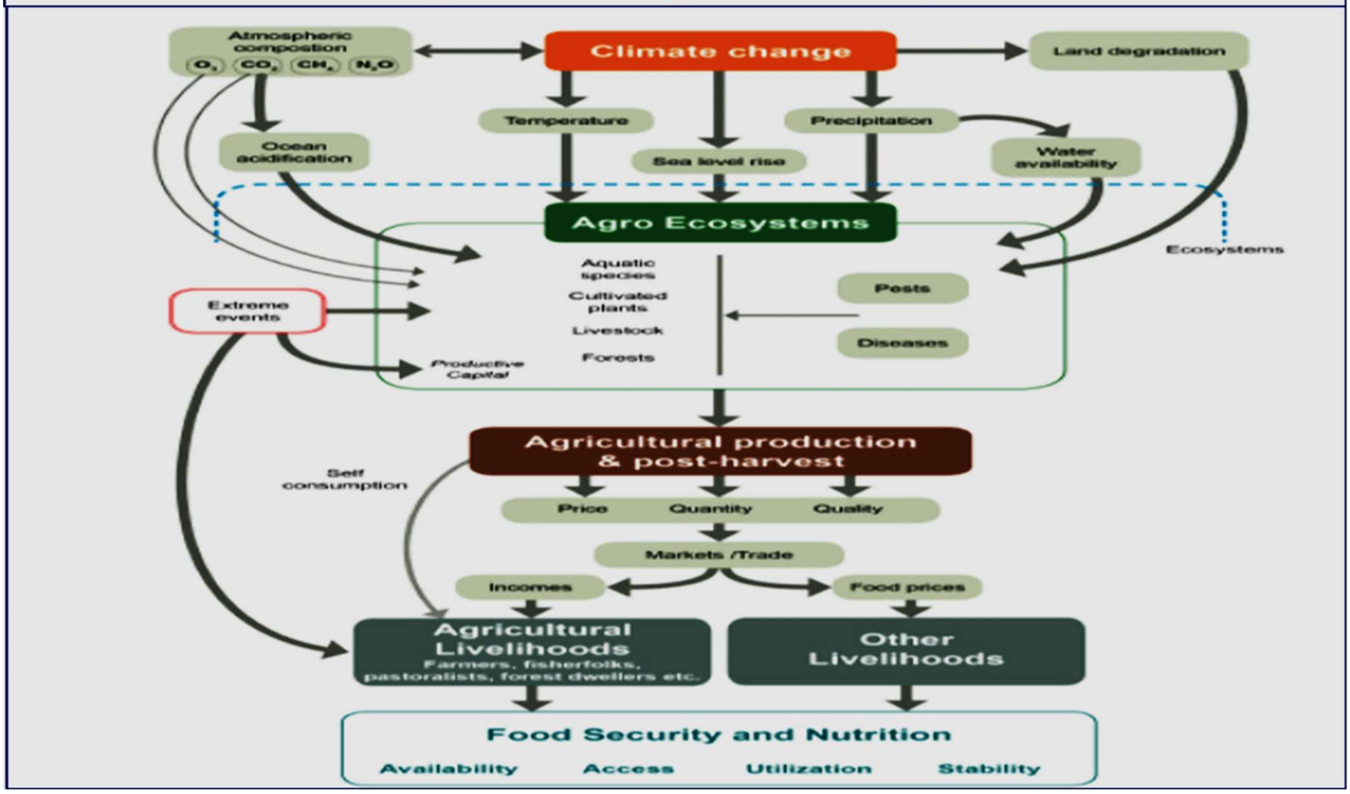
Climate change and extreme weather events

Climate change is likely to affect the frequency and intensity of extreme weather events. These have now become the new norm in many parts of the world. It rained for the first time at the peak of the Greenland ice sheet. A heat wave in Canada and adjacent parts of the USA pushed temperatures to nearly 50°C. The people of South Asia are living through a "new climate normal," where intensifying heat waves, cyclones, droughts, and floods are testing the endurance limits of governments, businesses and citizens. FAO's analysis of 78 post-disaster assessments between 2003-2013 in 48 developing countries showed that losses incurred by agriculture sectors amounted to 25% of all economic losses inflicted by extreme weather events (droughts, floods and storms). Immediate disaster management is critical for minimizing the life-threatening adverse consequences of extreme events. Disaster risk reduction (DRR) plans of the FAO are built on the premise that all phases of risk management (before, during and after extreme events) have to be linked, integrated and implemented in a sustained manner (Fig 16) and have to be addressed within the overall context of poverty and food security. In the post disaster period people will require rehabilitation to improve livelihood, food security, nutrition and health.

Climate change and Food security

Climate change can affect all four dimensions of food security: food availability, economic access to food, bioavailability and utilization of nutrients and stability of all these three dimensions. Food insecurity will lead to under-nutrition and illness. The interactions between climate change and food security are complex (Fig 17). Favourable conditions for food production may move geographically. Optimizing these conditions will require changes in crops, livestock, trees, and aquatic species breeding and management. Significant changes in agricultural systems and practices would be required to benefit from longer growing seasons in cold regions. Adaptation will be needed to counteract potential problems including proliferation of pests. Climate change impacts on production and translates into economic and

Fig 17 Climate change and food security



social consequences affecting food security of both on farm and non-farm households. At the farm/household level, climate change may reduce income level and stability, through reduction in productivity and increase in production costs. Reductions in disposable incomes may reduce the capacity and willingness of families to spend on health and education.

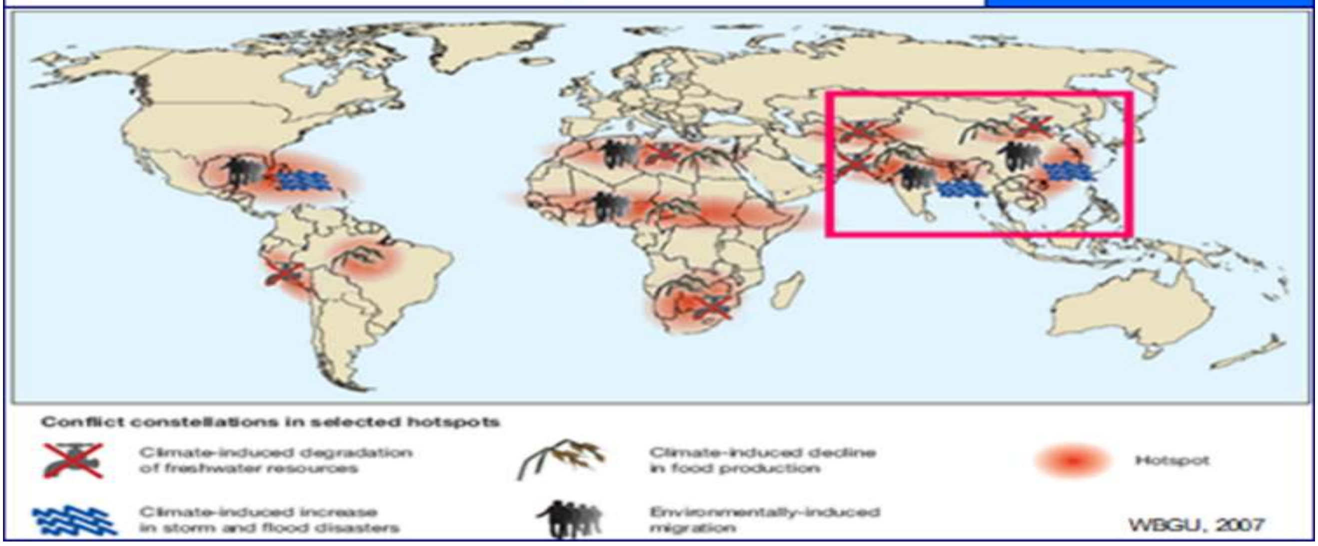
At global level, climate change can alter food security through impact on supply flows and export bans by some countries leading to market volatility and food price spikes. This results in global markets not being accessible to the poorest countries and the poorest populations with low purchasing power. At the national level climate change adversely affects macro-economic conditions in countries where agriculture is an important part of GDP and/or constitutes an important source of employment. Climate change can trigger shocks on agricultural production and food availability with risks of market disruptions, effects on supply and storage systems, increases in agricultural commodity prices (food and feed) impacting accessibility and stability of food supplies for the entire population, especially segments of population who are spending a large part of their income on food.

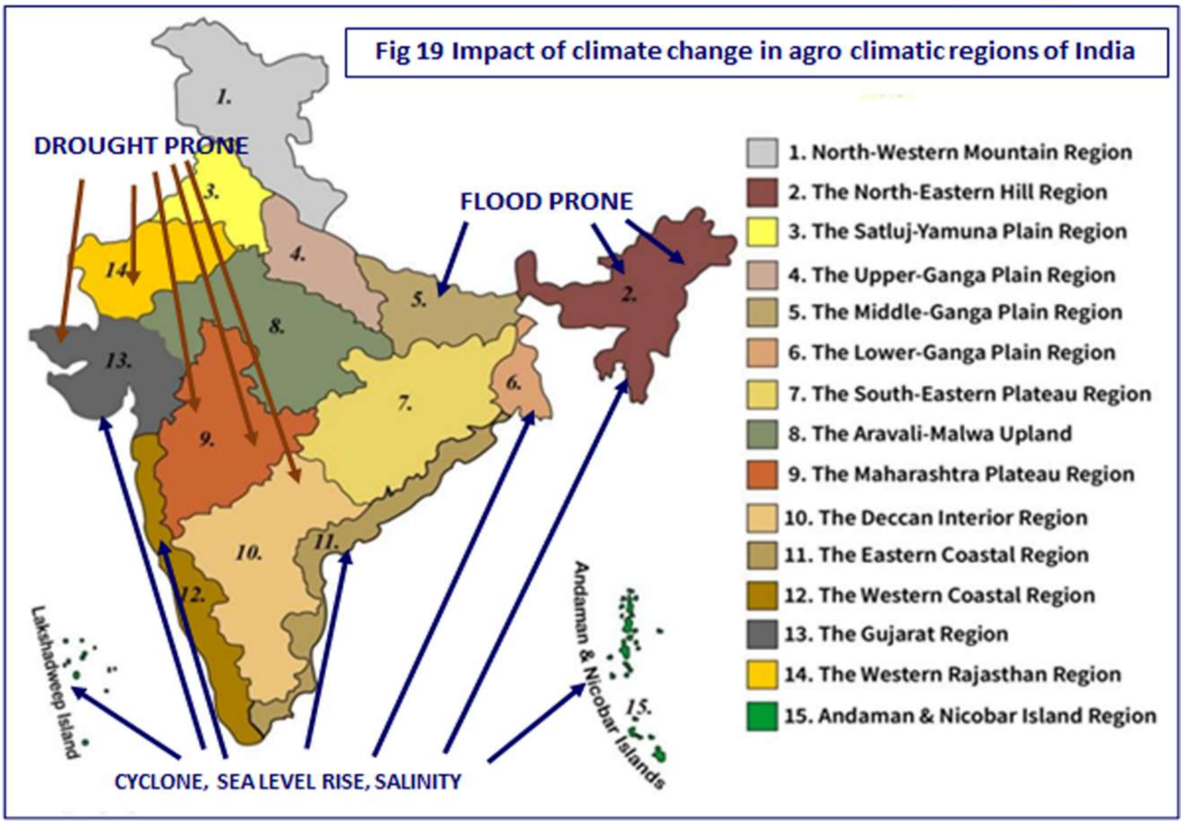
Climate change and food security in India

India is among the most vulnerable countries from adverse impact of the climate change- both in terms of

Fig 18 Hot spots of security risks associated with climate change: Asian Challenge

World Health Organization
Regional Office for South-East Asia





extreme climate events and food security (Fig 18). The risk of climate change associated adverse events in different agro-climatic zones in India is given in Fig 19. The question is often asked how do we identify the climate change related events so that we can intervene effectively. Climate change increases the frequency and intensity of extreme weather events, and events which adversely affect agri-system and food security. Interventions have to be broad based to address these problems, adapt to these changes and mitigate their adverse impact.

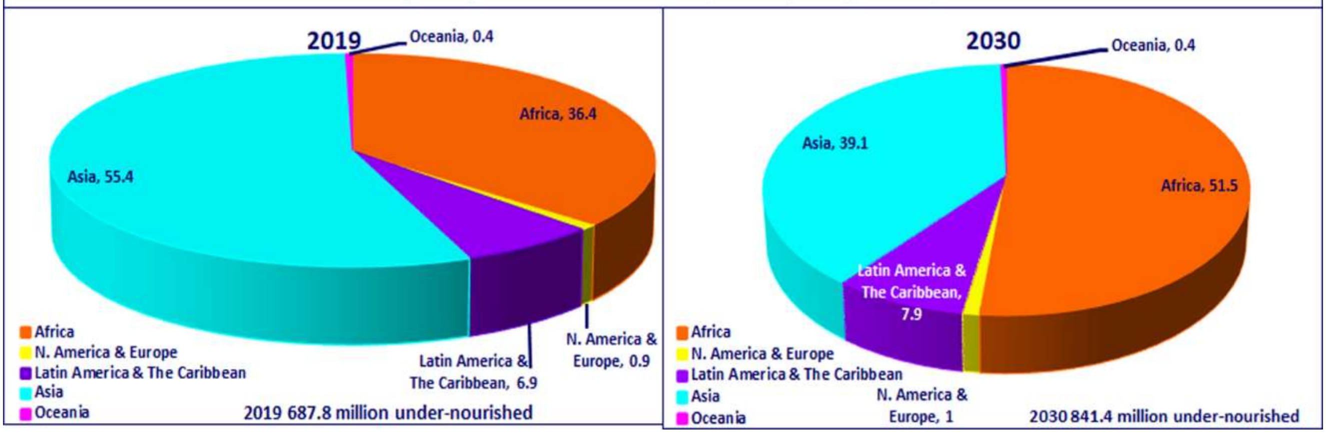
Over the last five years India had experienced severe extreme weather-related events in terms of:

- Severe cyclonic storms not only in Bay of Bengal but also in the Arabian Sea,
- Repeated floods in many states including Assam, Bihar and Kerala, and
- Floods in cities and metros eg Thiruvananthapuram Mumbai and Chennai.

In all these Disaster Management programmes were effectively and efficiently implemented; the affected population received needed support including shelter, food and health care. As a result, loss of life was minimised. However, programmes for rehabilitation and economic recovery were inadequate and require further strengthening.

India has been self-sufficient in food production for the last five decades. The average energy intake of the population is sufficient to meet the energy requirements. Under the National Food Security Mission and National Horticultural Mission India has evolved strategies and implemented programmes for improving pulse and vegetable production in the country sufficient to meet the needs of the population. In order to ensure household food security, the National Food Security Act provides 2/3rd of Indians subsidized food grains as a legal entitlement. During COVID 19 epidemic in India free food

Fig 20 Projections of under-nourished persons by 2030 (FAO 2020)



grains and cooked meals twice a day were given to all those who needed food. This prevented a sharp increase in food insecurity and under-nutrition during lock down. Global projections suggest that despite adverse impact of climate change the prevalence of under-nutrition in Asia (and India) will be substantially lower by 2030 (Fig 20). Multi-pronged strategies to cope with climate change related challenges to food production and food security in India include:

- mixed cropping, changing land use,
- development of sustainable and economically viable varieties of crops to cope with salinity, water scarcity or rising temperature through technology,
- improve land and water management, pest surveillance and control,
- assist farmers by providing weather services, agro-advisories, crop insurance, community banks for seed and fodder, and
- community/social measures to improve food security.

The action plans for climate change adaptation and mitigation have to address adverse impact of climate change on food security by:

- Informing farming community about impending weather-related problems such as drought and unseasonal rains. If drought is predicted:
    - farmers can be advised to sow pulse and millets instead of cereals
    - improving non-farm employment under MGNREGA
    - improve access to PDS under NFSA
    - improve access to supplementary feeding under ICDS and MDM.

If unseasonal rains and increased humidity are predicted efforts to improve processing and drying of vegetables and fruits will reduce wastage and income loss.

Strengthening of ongoing nutrition surveillance and monitoring is critical to assess the adverse impact of nutritional status and initiate appropriate interventions. To begin with district action plan for climate change could be undertaken in the vulnerable districts identified by NITI Aayog for intensive intervention.

Conclusion

Hindsight is 20/20; it is often easy to pick up lacunae in the formulation, funding and implementation of programmes aimed at reducing global warming and improving food security. The progress both in interventions to limit GHG emissions and improving food security have been suboptimal. Non-adherence to the Paris agreement pledges has resulted in continued increase in global warming. Since 2020, there has been actual deterioration in food security partly due to COVID 19 pandemic.

All countries should strive to effectively implement programmes for achieving food security and climate change goals with existing technologies. Concurrently greater investment in R&D for sustainable innovative technological solutions to global warming and food security have to be made.

Whenever challenged with an apparently disastrous future, mankind has come up with technological innovations which turned the challenge into opportunity. Some examples in the last century are:

- the green revolution which ensured that populous Asian countries did succeed in becoming self-sufficient in food production to meet the needs of rapidly growing population, and
- improvement in the availability and access to contraceptive care which enabled countries to achieve sustainable population growth within a short time.

During the next few decades development of alternative renewable sources of energy to replace fossil fuels and improved agricultural practices to cope with climate change related adverse consequences on food security can succeed in meeting these challenges and providing sustainable development for the planet, and the people.

Dr Prema Ramachandran is Director and Dr K Kalaivani is Deputy Director, Nutrition Foundation of India

Recommended reading

1. IPCC: Climate Change 2021: The Physical Science Basis (2021) https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/
2. World Meteorological office State of Climate in 2021: Extreme events and major impacts (2021) https://public.wmo.int/en/media/press-release/state-of-climate-2021-extreme-events-and-major-impacts
3. WMO Provisional Report on the State of the Global Climate 2021 https://www.rmets.org/news/wmo-provisional-report-state-global-climate-2021
4. FAO The state of the world's land and water: resources for Food and agriculture (2021) https://www.fao.org/publications/highlights-detail/en/c/1237820Systems
5. FAO State of food security and nutrition in the world (2021) https://www.fao.org/publications/sofi/2021/en/
6. FAO FAO's work on disaster risk reduction (2019) https://www.fao.org/publications/highlights-detail/en/c/1237820/

FOUNDATION NEWS

Foundation Day of the Nutrition Foundation of India was celebrated on 26.11.2021. Dr Madhavan Nair delivered the C Ramachandran Memorial lecture by webinar on "Addressing iron bio-availability: Core strategy to achieve Anaemia Mukt Bharat". The webinar was well attended and his lecture was highly appreciated.