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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(4): 331-334

www.thepharmajournal.com
Received: 19-02-2022
Accepted: 22-03-2022

Amith G
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Hemareddy Thimmareddy
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Ramesh
UAS, GKVK, Bengaluru, Karnataka, India

Mahesh Haroli
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Guna M
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Dharani C
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Corresponding Author
Amith G
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Adaptation and mitigation in agriculture to climate change

Amith G, Hemareddy Thimmareddy, Ramesh, Mahesh Haroli, Guna M and Dharani C

Abstract
Climate has been main influential factor and having direct effects on agricultural production. The effects of agriculture on GHG emissions are also large. Agriculture is a major part of the global economy and uses substantial fossil fuel for farm inputs and equipment. Livestock's releases substantial GHGs in the form of nitrogen and methane. The core challenge of climate change adaptation and mitigation in agriculture is to produce (i) more food, (ii) more efficiently, (iii) under more volatile production conditions, and (iv) with net reductions in GHG emissions from food production and marketing. Higher temperatures in already-hot regions will likely reduce crop yields and effectively shorten the growing season. Concerns about mitigating and adapting to climate change are renewing the impetus for investments in agricultural research and are emerging as additional innovation priorities. This adaptation and mitigation potential is nowhere more pronounced than in developing countries where agricultural productivity remains low; poverty, vulnerability and food insecurity remain high; and the direct effects of climate change are expected to be especially harsh. Adaptation to new traits and varieties of crops or shifting to a totally different mix of crops will be required to cope with dramatic changes in rainfall or temperature, and cropping systems will fundamentally change as a result. Improvements in crop yields per unit of land are crucial as an alternative to extensive conversion of grassland and forestland to crops. Therefore, practices or technologies with potential to increase the intensity of land use can yield mitigation benefits. As climates become hotter and precipitation more erratic, the potential for postharvest losses may increase and thus improved transport and storage become even more important. Post-harvest GHG emissions per unit of consumption mainly depend on efficiencies of transport rather than distance travelled. Awareness and proper implementations of weather-based crop insurance schemes (WBCIS) may aid farmers to adapt to climate change. This is especially helpful in the areas which are exposed to greater variability and more frequent extreme events.

Keywords: Climate change, mitigation, adaptation, GHG

Introduction
Climate change is basically change in the long term average weather phenomenon or parameters which have substantial negative or positive impacts on the life on earth. Climate change is continuous process which has occurred in the past, is occurring now and will happen in the future also. Its not the climate change we have to worry about but its the pace at which the climate change is happening. The time taken for climate change decides the evolution and acclimatization of living organisms on the earth. In the present scenario because of exponential change in the climate, their is no enough time for acclimatization or evolving of organisms.

What the AR6 report says about India?
India will face major threats from rising sea levels because of its over 7000 km coastline. Additionally, the Indian Ocean is warming faster than the global average. About 28.6 million people would be vulnerable to coastal flooding across the port cities of Kochi, Kolkata, Chennai, Surat, Visakhapatnam and Mumbai. Retreating snowlines can cause changes in the precipitation patterns, water cycle, increased flooding and increase water scarcity also in the states across the Himalayas. Both the summer and the annual monsoon precipitation is expected to increase (Shukla *et al*., 2019) [8].
Agriculture is a human activity that constantly changes in response to changing conditions. Thus, while agronomic models assess the impact of changes on crop yields and may explicitly define the scope of feasible technical adjustments producers make in response to these changes, the net effect depends at least as much on how producers respond to changing constraints and market incentives induced by these changes (Gornall, 2010) [2].

Climate has obvious and direct effects on agricultural production. The effects of agriculture on GHG emissions are also large. Agriculture is a major part of the global economy and uses substantial fossil fuel for farm inputs and equipment. Animal agriculture also releases substantial GHGs in the form of nitrogen and methane (Malik *et al*., 2016) [6].

According to IPCC 6th assessment report, all the countries should have the GHG emission by this decade and should become zero emission by 2050 so that the temperature rise could be restricted to 1.5 °C from the present (Fig 1).

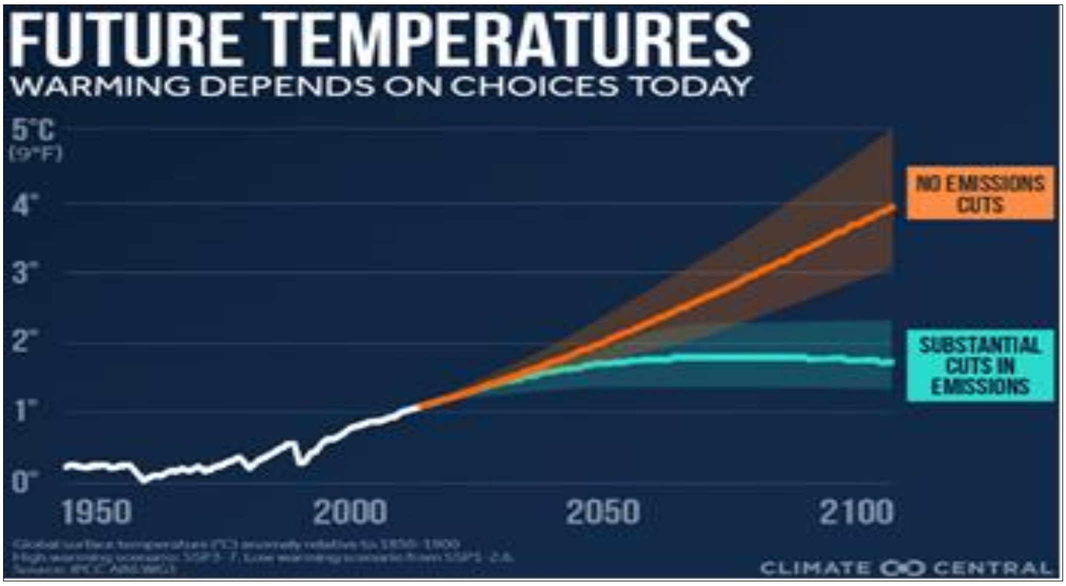

Fig 1: Projected temperature variability with respect to emissions

Estimating how climate change will affect agriculture adds complexity and uncertainty to already complex climate change models. Amidst this complexity and imprecision, a fairly consistent pattern of direct agricultural impacts emerges: agriculture in temperate North America, Europe and Asia is likely to benefit from higher mean temperatures and longer growing seasons, while agriculture in much of the rest of the world will likely suffer declines in productivity (Siwar *et al*., 2009) [9]. Higher temperatures in already-hot regions will likely reduce crop yields and effectively shorten the growing season by introducing (longer) periods of excessive heat. The best estimates currently available, which combine forecasts from the agronomic and limited economic modelling approaches, suggest that the aggregate impact of these effects will reduce global agricultural production by 6% by 2080 from what would otherwise occur. In this contest, a brief view on adaptation and mitigation to climate change in agriculture is drawn from various studies and portrayed.

Results and Discussion

Concerns about mitigating and adapting to climate change are renewing the impetus for investments in agricultural research and are emerging as additional innovation priorities. In the coming decades, the development and effective diffusion of new agricultural practices and technologies will largely shape how and how well farmers mitigate and adapt to climate change. This adaptation and mitigation potential is nowhere more pronounced than in developing countries where agricultural productivity remains low; poverty, vulnerability and food insecurity remain high; and the direct effects of climate change are expected to be especially harsh. (Lybbert and Sumner, 2012)) [5].

Adaptation in rainfed agriculture

The monitoring of rainfed crops is based on the following principal tools: Use of real-time meteorological data; Use of crop-specific water balance models; Processing of real-time satellite images (mainly by NOAA, SPOT – Vegetation and Meteosat satellites); Use of spatial interpolation tools; Use of gridded surfaces of crop-related parameters derived, or not, from satellite images (e.g., soil water holding capacity, soil type, land cover, land use, crop area sample, etc.); Use of seasonal forecasts; Field sample surveys, mainly for harvest estimates (Supit *et al*., 2012) [10].

Recommendations of the IPCC

Countries should strive for net-zero emissions by 2050. Severe cuts are required in GHG emissions in this decade itself (2021-30). New coal plants and fossil fuel exploration and development should be ended. Governments, businesses and investors should work towards a low-carbon future. Cumulative emissions should be factored in while calculating net zero. Technology should be developed for bringing about negative emissions, which means, the planet should be cooled down. This can be done by sucking out or sequestering the carbon from the atmosphere and stopping the use of fossil fuels and stopping deforestation (Shukla *et al*., 2019) [8].

Adaptation with new varieties and cropping system

In many places, new traits and varieties for the crops farmers have traditionally cultivated will confer sufficient scope for adaptation. In other places, shifting to a totally different mix of crops will be required to cope with dramatic changes in rainfall or temperature, and cropping systems will fundamentally change as a result. Even if adaptation does not imply an entirely new mix of crops, many producers will benefit from new crops and varieties as they diversify their production portfolios as a means of stabilizing their revenue or local production of basic foods in the face of more volatile conditions. These diversification benefits will be important because many households and many regions will continue to produce their own food even decades from now, when transportation, communication and financial infrastructure has penetrated many areas that are currently poor and remote.

Soil amendments for improved productivity

Improvements in crop yields per unit of land are crucial as an alternative to extensive conversion of grassland and forestland to crops. Therefore practices or technologies with potential to increase the intensity of land use can yield mitigation benefits. This may even include application of additional fertilizer or pesticide inputs, where the "first round" GHG implication may not look favourable. There are, however, other amendments such as biochar, a charcoal soil amendment, that may offer both improved soil fertility and serve as a carbon sink (Lehmann, *et al*., 2006) [4].

Post-harvest activities

Post-harvest losses represent one of the single greatest sources of inefficiencies in food production worldwide and therefore one of the best opportunities for effectively improving crop productivity. These losses – which are due to poorly timed or executed harvesting, exposure to rain, humidity and heat, contamination by microorganisms, and a host of other sources of damage and deterioration – often get far less attention than they deserve. Half or more of the total harvest of some crops can be lost post harvest. Investments in improved harvesting, processing, storage, distribution, and logistics technology and necessary training investments can pay off as well as improved crop yields in terms of gains to consumers and the climate. As climates become hotter and precipitation more erratic, the potential for postharvest losses may increase and thus improved transport and storage become even more important (Chegere, 2018) [1]. It is well known that transportation is a major contributor of GHG emissions. Post-harvest GHG emissions per unit of consumption mainly depend on efficiencies of transport (rail versus road, ocean shipping versus land shipping, and large loads versus small loads) rather than distance travelled.

Awareness about WBCIS

Innovations in microfinance generally and in micro-insurance products specifically may aid farmers' capacity to adapt to climate change. This is especially true in production settings that are exposed to greater variability and more frequent extreme events. The dramatic expansion of smart phone networks into rural areas of developing countries and the emergence of internet-based banking services will only speed farmers' integration into financial markets (Nagar and Bhatia, 2010) [7]. In this context farmers need to insure their crop through government schemes like Weather based crop insurance schemes (WBCIS) or Pradhan mantri fasal bhima yojana (PMFBY) which have state and central government premium subsidies. Government should also promote private insurance companies for reaching this facility to remote farmers by giving them incentives for insuring crops.

Actions to be taken by policy makers

Governments should require climate change adaptation measures by farmers but they should account for local conditions. Existing evidence shows there is a need for agriculture to undertake climate change adaptation actions, if only to reduce projected damages. Government policy should complement farmers' own adaptation actions, he said. Farmers already are taking actions to adapt to climate change. Government's role is necessary in the presence of market failures or where the condition for adaptation accesses the public good (Alex Binkley, 2018).

Rewarding Early Adopters

Participatory research into climate change adaptation options can help agricultural decision makers realize that acting on the existing trends in climate now is likely to be to their advantage. For example, in northeast Australia, crop management that has continuously adjusted to the progressive reduction in frost risk experienced over the past several decades can almost double gross margins when compared with management based on either the long-term risk or management that does not consider frost risk (Howden *et al*., 2007) [3]. Participatory engagement with decision makers, by bringing their practical knowledge into the assessment, can also identify a more comprehensive range of adaptations than are typically explored by scientists, as well as being able to assess the practicality of options and contribute to more realistic assessment of the costs and benefits involved in management or policy change.

Conclusion

It is a fool's errand to attempt to fully catalog for climate change mitigation and adaptation over the next decades. If history is any guide, the most important such technologies have yet to be developed or even conceived. The implementation of adaptation strategies to be done with the interventions of public, private and state. The conglomeration could help in adapting swiftly to the possible predictions. More multilocational climate studies in agricultural could build up the base for mitigating and adapting to new technologies. The development and effective diffusion of new agricultural practices and technologies in the coming decades will largely shape how and how well farmers mitigate and adapt to climate change. This adaptation and mitigation potential is nowhere more pronounced than in developing countries like where agricultural productivity remains low; poverty, vulnerability and food insecurity remain high; and the direct effects of climate change are expected to be especially harsh. A crucial part of adaptation to climate change is the assessment framework that can equitably engage farmers, agribusiness, and policymakers, leveraging off the substantial collective knowledge of agricultural systems, yet focusing on values of importance to stakeholders.

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