IMPACT OF CLIMATE CHANGE

MITIGATION & ADAPTATION MEASURES FOR PRODUCERS OF CROPS

AUGUST 2021

Contribution:

This document was prepared by Harsh Jha with the support of Mrunmayee Velukar under the overall supervision and guidance of Priyesh Salunke.

Disclaimer:

Cover photo: Thangaraj Kumaravel, Flickr CC, 2021

Introduction

Climate Change in a Global Context

Climate change is a scientifically proven fact, and its impact on our current ecosystem a.k.a "the world we live in," has left a sense of concern among the economist, environmentalist, and agriculturists to re-evaluate their plans to minimize the direct losses in terms of human, natural, and economic resources. Unfortunately, at the current development phase and ongoing environmental exploitation, the only future left to see will be filled with collapsed ecosystems and severe health issues, influencing people to adapt to the ecological changes and suffer extensive losses.

Especially to the agricultural sector, climate change is a severe threat (Malhi, Kaur, & Kaushik, 2021). A slight increase in mean temperature or change in the precipitation pattern can cause enormous damage to the agriculture and food security sector. It starts from the degradation of the quality of produce to 100% crop failure in just a 1-2°C increase in the mean temperature. Moreover, according to the United Nations, the world's population is expected to increase by 2 billion in the next 30 years, i.e., from 7.7 billion currently to 9.7 billion in 2050 (UN, 2019), resulting in increased pressure on our farmers to cater to the demands to feed such massive population while facing the problems of climate change.

Moreover, as per the Intergovernmental Panel on Climate Change (IPCC), at the current rate of warming at 0.2°C per decade, global warming will reach 1.5°C (BBC, 2019) or even higher between 2030 and 2052, making it more difficult for farmers to protect themselves on their own of the adverse impacts of this global temperature rise, especially in the third world countries. One such international initiative is the Paris Agreement, aimed towards limiting global warming to 1.5°C by planning and managing GHG emissions, use of renewable energy, the magnitude of the type of energy use, and implementation of better climate

Problems faced by Producers of Crops

In the past 100 years, the climate has changed all over the globe, resulting in increased events of floods, droughts, irregular patterns of rainfall or precipitation, devastating heat waves, extreme temperatures. Generally, the impact of climate change is evident in almost all sectors, but the agricultural industry is the most vulnerable to climate change due to its high demand and sensitivity towards weather parameters. Currently, this sector alone has a responsibility to feed 7.7 billion people worldwide while tackling problems associated with climate change. However, the World Food Programme (WFP) report of 2018 revealed that the increase in crop yield per hectare is significantly slower than rising population rates. Sadly, rising temperature is one of the significant contributors to the reduction of crop yields (Kumar R, Gautam HR, 2014).

The impact of global climate change on the primary production of food as whole, forces the unaware farmers and agricultural labours to constantly adjust to abnormal or atypical

weather conditions. For example, a reduction in snow cover in some areas can cause poor yields of winter cash crops. The effects also involve abnormally hot summers and frigid winters, or equally alarming warm winters and chilly summers.

Another significant impact of climate change on agriculture is the continuously changing precipitation pattern that makes these vulnerable farmers arrange artificial irrigation plans to water the crops, which was done naturally earlier, making the entire process economically and environmentally costly. Moreover, when the rainfall is heavy, its excessive moisture may also be a problem, causing floods and destroying the whole crop production, especially those which need a small amount of irrigation. Sometimes, a rise in temperatures results in pest infestations involving higher insecticide applications and more water resources.

The agricultural industry is the most vulnerable to climate change due to its high demand and sensitivity towards weather parameters. Currently, this sector alone has a responsibility to feed 7.7 billion people worldwide.

Agriculture and Climate Change

Indeed, it's clear that even a small climate change can cause severe threats to agriculture and its food produce. However, it is also essential to note that even the agricultural and food production sector has its fair share of contribution to climate change. The important reasons behind it are the emissions of anthropogenic greenhouse gases and an increase in carbon footprint caused by converting non-agricultural land into agricultural land or using more land to cater to the loss from the reduced crop yield.

In 2020, the European Union's Scientific Advice Mechanism estimated that the food system as a whole made up 37% of total greenhouse gas emissions, and this could keep increasing if proper planning is not carried out. It is essential to understand that even the mode of transportation of these agricultural goods affects the carbon footprints, and the requirement is to plan things so that these issues are addressed. e.g., produce transported in a ship from the same place will have a lesser carbon footprint from the same product transported via air.

As per Food and Agriculture Organization (FAO) data published in 2016, if the current situation of GHG emissions and climate change continues, then by the year 2100, there will be a decline in the production of major cereal crops (20–45% in maize yields, 5–50% in wheat

and 20–30% in rice). According to researchers, these percentages might increase, seeing the world's current situation during the COVID-19 pandemic.

So, if these trends continue on similar lines, crop failure and yield loss will very shortly affect the majority of farmers all across the globe. Also, a reduction in the food supply will spike the food prices, directly affecting the poor section of society.

Therefore, there is an urgent need to implement policies that can reduce the risk of adverse climate change impacts on the agricultural sector, reduce greenhouse gas emissions, and promote carbon-neutral farming practices.

Agriculture and Climate Change in the Indian Context

Similar to the global setbacks, climate change in the Indian context directly affects crop yields, growth rate, and quality of food products, all because of changing day/night temperature, frequent heat waves, rising sea level, and rapidly changing precipitation patterns. For example, rice production in Jharkhand, Odisha, and Chhattisgarh has sustained huge losses in the past few years due to increased temperature causing water scarcity in the region. Also, the livelihood of more than half of India's workforce,50-60% (Ministry of Statistics and Programme Implementation, 2021) depends on agriculture and allied activities; however, the GDP share of this sector is not more than 20.19% (Ministry of Statistics and Programme Implementation, 2021). These figures clearly show an urgent need for intervention in this sector to enhance the value of yield and revenue from this sector.

The population projections of the next few decades provide a good insight into the increased requirement of food products for the future, and indeed, climate change will become the major hurdle for the food producers to increase the current yield and face the consequences of climate change.

...even the agricultural and food production sector has its fair share of contribution to climate change... reasons behind it are the emissions of anthropogenic greenhouse gases

Climate Change Performance Index

Since 2015-16, with the signing of the Paris Agreement to cut GHG emissions by 35% by 2030, India has worked tirelessly in this area, ranking in the top ten in the CCPI report since 2019.This ranking has been done between 57 selected countries and the entire European Union based on four categories- Annual GHG emission, annual use of renewable energy, type of energy use, and climate policy. These 57 countries and EU collectively is responsible for about 90% of the GHG Emission. Although still, India can work upon various parameters depending on its current scores in all four categories.

Table 1: Climate Change Performance Index - India

Indicator	Total Scores	Score Obtained	Global Ranking
GHG Emissions	40	29.39	12
Renewable Energy	20	7.89	27
Energy Use	20	14.77	10
Climate Policy	20	12.92	13
Global Ranking	100	63.98	10

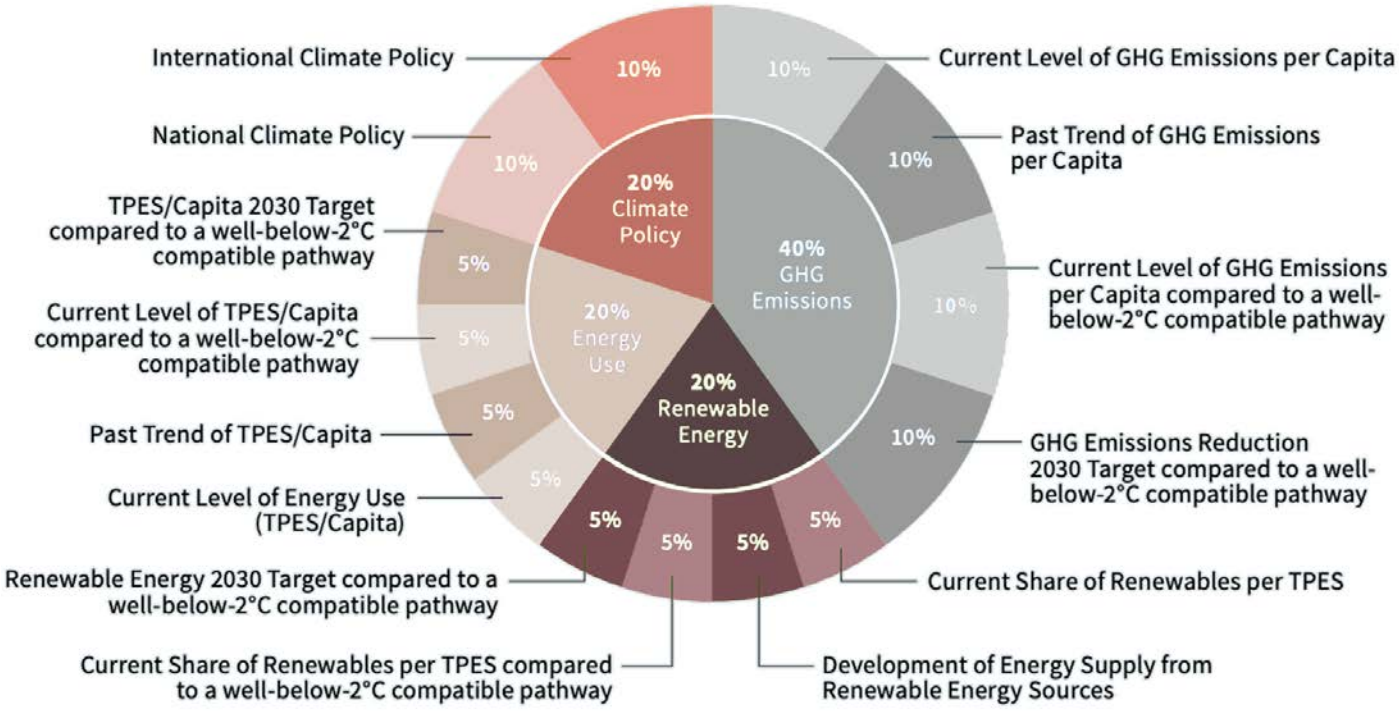

Fig. 1: Components of CCPI (Kapoor & Mooney, 2021)

Need for Sustainable Agriculture

Today, the world is talking about climate change and sustainable development goals on numerous platforms. Everyone has a similar objective of reducing carbon emission and Green House Gases to curtail the impacts of climate change on agriculture. Currently, the United Nations Sustainable Development Goal of eradicating hunger by 2030 is a challenging target to achieve.

As per FAO reports, beyond 2030 (basically, a decade from now), negative impacts of climate change will affect the agricultural produce severely in all parts of the world. Since agriculture, land use, and forestry contribute majorly to GHG emissions, it becomes essential for the policymakers, experts and farmers to think and plan the reduction of these levels for a sustainable future. This indeed sounds

Similar to the global setbacks, climate change in the Indian context directly affects crop yields, growth rate, and quality of food products, all because of changing day/night temperature, frequent heat waves, rising sea level, and rapidly changing precipitation patterns.

difficult to achieve, but it's the will to work together more crucial. When nature strikes, we need to remember that it hits the entire humanity, not a particular section of society.

A Climate-smart agriculture system can accomplish these sustainable food and agricultural goals. Sustainable management of resources plays a crucial role in declining carbon footprint. Especially small-scale farm practices, improvement in present infrastructure, detailed climate information, soil fertility, balance in carbon-nitrogen emission, and carbon-neutral market access can help farmers adapt to climate change.

Otherwise, the loss of crops and livelihood due to climate change will be far more than the cost of providing these facilities to the farmers. It is essential to keep a check on the emission levels. Effective management of agricultural ecosystems by promoting sustainable farming practices will reduce the impacts of climate change.

The majority of interventions can be carried out by developing well-adapted resilient varieties of seeds and crops to tolerate extreme

Location	Crop	Climate-Smart Technology	Enhanced Efficiency	Incremental Economic Benefit
Vietnam Philippines India	Rice	Site-specific nutrient management	Increased partial factor productivity of nitrogen	34 US$/ha 106 US$/ha 168 US$/ha
Sindh, Pakistan	Wheat	Laser land leveling	Saving of 21% irrigation water and reduced irrigation time	INR 23,250/acre
Punjab, Pakistan	Rice-wheat cropping system	Zero tillage Bed furrows Laser land leveling	Higher water productivity, saving of irrigation water, and higher fertilizer use efficiency	-
Nyando basin of Kenya	Multiple crops and livestock	Stress-tolerant crop varieties Improved livestock breeds	Increased household income leading to household asset accumulation and investment	Increased HH income by 83% Increased HH income
Semi-arid tropics of India	Groundnut	Drought-tolerant varieties	Increase in yield by 23%, lower variability in yield, increased share of risk benefits in total benefits	17% reduction in variable cost
Karnal, Haryana	Wheat	Zero tillage	Enhanced production by 1.88% and lower cultivation cost	Higher net income
Northwestern Indo-Gangetic plains of India	Rice and wheat	Laser land leveling	Reduced irrigation time, increased yield, reduced electricity charges	US$ 143.5/ha/year
North western India	Wheat	Zero tillage	Reduced cultivation cost, reduced GHGs emissions, and increased yield	US$ 97.5/ha
Upper Gangetic plains	Wheat	Site-specific nutrient management	Increased yield by 29% over farmers fertilizer practices (FFP)	INR 68,980/ha over FFP
Indo-Gangetic plains of India	Rice–Wheat cropping system	Improved crop varieties Laser land leveling Zero-tillage	Increased net returns	INR 15,712/ha/yr INR 8119/ha/yr INR 6951/ha/yr
India	Rice	Direct-seeded rice	Reduced irrigation and preparation costs	Increase HH income by 16%
Tamilnadu, India	Okra	Drip irrigation	Saving of irrigation water and electricity charges, reduced cultivation cost	INR 72,711/acre
Punjab, India	DSR–Wheat	Direct-seeded rice	Saving of irrigation, lesser labor requirement	INR 5050–INR 8100/ha over puddled transplanted rice (PTR)–Wheat
India	Eggplant	Drip irrigation	Reduced water, electricity and fertilizer use, and increased returns	54% higher net returns

Fig. 2: Climate-smart agriculture technologies and Economic Benefit (Malhi, Kaur, & Kaushik, 2021)

temperatures and changing precipitation patterns. Also, the application of various bio inoculants, biofertilizers, sustainable pest management, and organic farming methods can get a good yield of crops in a very extreme environment in sustainable ways.

The use of biofertilizers and biopesticides can drastically reduce GHG and population as it reduces the reliance on chemical fertilizers and pesticides. In addition, methods like changing crop cultivars, conditional changing of sowing time, and modern cultivation techniques like mixed cropping systems provide durability to the crops in extreme weather events. Thus, Climate-smart agriculture is a new but effective method for sustainable agricultural practices.

Therefore, mitigation methods for adapting agriculture to climate change broadly involves the development of seeds and cropping pattern which are tolerant to extreme weather conditions, effective soil management by reducing its depletion, promoting carbon sequestration, effective use of natural resources, eliminating the use of chemicals and reducing the harmful emissions.

Furthermore, being informed of weather reports and changes in climate and being prepared for it can reduce losses caused, as an early information system helps farmers mitigate the effects efficiently and effectively in time. Moreover, to minimize climate change impacts, methods like rainwater harvesting, improved irrigation systems, precision farming, cover crops, and adaptive crops can be used.

...mitigation methods for adapting agriculture to climate change broadly involves the development of seeds and cropping pattern which are tolerant to extreme weather conditions, effective soil management by reducing its depletion, promoting carbon sequestration, effective use of natural resources, eliminating the use of chemicals and reducing the harmful emissions.

Above all, it is essential to educate farmers about the new and modern sustainable agriculture techniques to improve their livelihood opportunities and save the ecosystem. To achieve these sustainable goals, planning at the global level and acting locally is of utmost importance.

Conclusion

Climate change and Agriculture Industry are deeply interlinked to each other. Now, it is necessary to mitigate the impacts of climate change to stop hindrance to the livelihoods of the farmers and save poor consumers from starving due to price hikes. Even increasing demand for agricultural produce due to losses incurred by climate change and rising population can likely lead to more exploitation

of natural resources like land and water, which will further increase the GHG and carbon emission levels.

Farmers and agriculturists have to adopt modern sustainable agriculture practices to reduce carbon footprints and save resources while producing. As the climate is not the same as before, farmers must be aware enough to tackle the problems from changing temperatures and sustainably mitigate them to reduce the losses.

Also, knowledge about how climate affects agriculture is essential for decision-making on the farming method to be adopted for better yield. This could be something they have never come across. It is the agriculturists and experts who must research and figure out how to minimize the loss and maximize the gains while protecting the ecosystem.

Policy and decision-makers are required to strengthen their capacity to plan and implement policies that can address agriculture and climate change problems holistically. Whether it be the Kyoto Protocol or the Paris Agreement on Climate change or Sustainable development goals, the requirement is to implement these international efforts on the ground. That is how we can mitigate the impacts of climate change and achieve a peaceful ecosystem.

Key Takeaways

1. Agricultural and food sector contributes to climate change, emission of anthropogenic greenhouse gases and an increase in carbon footprint.

2. It is essential for the policymakers, experts, and farmers to think and plan the reduction of GHG emissions levels without compromising the need of today and tomorrow.

3. Developing well-adapted resilient varieties of seeds and crops to tolerate extreme temperatures and changing precipitation patterns.

4. Replanting forests and restoring damaged ecosystems. Optimizing irrigation systems, including the use of central computerized oversight. Installing netting over orchards to reduce evaporation.

5. Developing soil moisture management plans, using, for example, neutron probes to measure the quantity of water present in the soil. Selecting and planting cultivars suited to water availability and soil type.

6. Planting cash crops to act as a living mulch in orchards – amongst others. A living mulch is a cover crop the main crop and intended to serve the purpose of a mulch, such as weed suppression, regulation of soil temperature, and reduction of water run-off and soil erosion.

7. Reducing the emissions intensity along the entire agricultural supply chain, including avoided land-use change driven by agriculture. Sequestering additional carbon in agricultural systems.

Photo credits: Thangaraj Kumaravel, Flickr CC, 2021

References

1. BBC. (2019, July 11). Climate change: How hot cities could be in 2050. Retrieved from bbc.com: https://www.bbc.com/news/newsbeat-48947573

2. Kapoor, R., & Mooney, T. (2021). New Global Container Port Performance Index. World Bank & IHS Markit.

3. Malhi, G. S., Kaur, M., & Kaushik, P. (2021). Impact of Climate Change on Agriculture and Its Mitigation. Sustainability .

4. UN. (2019, June 17). Growing at a slower pace, world population is expected to reach 9.7 billion in 2050 and could peak at nearly 11 billion around 2100. Retrieved from un.org: https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html

5. Ministry of Statistics and Programme Implementation (2021). https://statisticstimes.com/economy/country/india-gdp-sectorwise.php

6. Malhi, G.S.; Kaur, M.; Kaushik, P. (2021). Impact of Climate Change on Agriculture and Its Mitigation Strategies: A Review. Sustainability 2021, 13, 1318. https://doi.org/10.3390/su13031318

7. Kumar R, Gautam HR (2014) Climate Change and its Impact on Agricultural Productivity in India. J Climatol Weather Forecasting 2:109. doi:10.4172/2332-2594.1000109

About the Authors

Priyesh Salunke
psalunke@taru.co.in

Priyesh Salunke is a Partner and Director at Taru Leading Edge, a Development Advisory and Think-Tank delivering innovative transformative solutions and insights in the Development Space.

Mrunmayee Velukar
mvelukar@taru.co.in

Mrunmayee Velukar is an Urban Planner with experience in Urban Infrastructure and Climate Responsive Planning.

Harsh Jha
jhaharsh786@gmail.com

Harsh Jha is an Urban and Regional Planner, motivated towards contributing to social and environmental sectors.