



IMPACT OF CLIMATE CHANGE ON AGRICULTURE PRODUCTION IN INDIA

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ABSTRACT

Agriculture is known for the most prominent aspects that is much recognized by our Indian economy. It is considered to be very important sector because it provides sustainable life to half the population. Since most of the people are dependent on agriculture sector because it not only focusses on providing income to the people but also considers various other factors such as raw material requirements that is needed for production activities, provides a platform to market the industrial products, employment opportunities and providing food grains as to satisfy the entire population needs. In the years between 2019-2020, there was a record that hits to 291.95 million tones which was estimated as the total production of food grains in the country. By the year 2030, the demand for food grains would be increased which was predicted by the Indian Council of Agriculture Research. But sometimes they might be a downfall with the changes in the agriculture production patterns. This is the place where the climate change plays really important role on deciding the positive or the negative results that may cause fluctuation in the movements of agriculture practices. Agriculture is also considered to be a main source that leads in greenhouse gas emission by contributing to the changes in terms of climate plus with greenhouse effect. Changes in the climate has created fluctuation in the agriculture production which might gradually end up as a challenge in the food insecurity in the near future. So therefore, this paper fully focuses on how climatic changes has impacted the agriculture production patterns, focusing on the factors that can influence the climate change which can be a major reason for food insecurity and analysis of policies that our implemented to cope with the challenges of climate change in order to bring in positive change in the economy.

JEL Classification: L25, Q12, Q51, Q54

KEY WORDS: Food insecurity, policies, Climate change, Agriculture production and food grains.

OBJECTIVES

- To analyze how climate change has impacted the Indian agriculture.
- To study the factors that can influence the climate change for creating a situation of food insecurity.
- To show the policies that are being implemented to cope with the challenges of climate change.

Research Methodology:

This paper is fully based on the secondary data that shows how climate change has played a very important role in the Indian agriculture. Graphs has been made on the basis of increase in carbon dioxide and rise in the temperature of the Indian economy. This paper also focusses on the policies that have helped in coping up the risks of climate change in order to increase up the productivity.

Introduction:

Agriculture is found be known as the most important sector in the Indian economy. Since it is more vulnerable towards the fluctuation in the climate change, can result in having either positive or a negative effect based on the regions characteristics. Changes in the Co₂ emission, precipitation and temperature can have a major impact on the changes in the crop pattern. Not just on the crop pattern but it might lead to a greater effect on the food production that may challenge the food security in the near future. The important factor to be noted is that climate change is mainly caused by the Greenhouse gas emissions (GHG) where India stands in the third position after United states and China economy. Rise in the level of greenhouse gas emission leads to global warming. This global warming situation may cause food scarcity and there would be impact physiological mechanism affecting both plants and animals' productivity. From the report given by the International Energy Agency stated that India emitted carbon dioxide with an estimation about 2,299 million tons in the year 2018 which accounts about 7% of the total global emission. About 18% of gross national emission is mainly accounted by the livestock and agriculture. It has been seen that the overall emission normally occurs during the time of primary production stage by using agriculture inputs such as water, pesticides and fertilizers, irrigation, residue management, farm machinery and soil disturbance. So therefore, agriculture sector has acted as the main reason for the emission of greenhouse gas with in turn has affected severely because of the climate change. Now due to frequent heat waves, dry spells and unstable rainfall changes has been threatening the total agriculture output of the Indian country. The main challenge that poses here is the increasing demand for the production of food. Fluctuations in the climate change can be a reason where the prices of food can increase since it can contribute to food insecurity in the upcoming generations. Over the decades, increase in population has lifted up the demand for water because of urbanization and industrialization initiatives. Agriculture must adapt to climatic changes by tapping into water resources and bringing about a better plan for the management of water. After all this also contributes to the increase in the production of crops. So therefore, this has to be taken care of with a proper control over the emission of greenhouse gases. From the recent analysis given by International Maize and wheat improvement center indicated that India can actually cut down its greenhouse gas emission in terms of agriculture and livestock about 18%. This study showed that by implementing efficient use of fertilizers, better management of water and adoption of zero tillage measures can be used in reducing at least 50 % of the greenhouse gas emission. Need of policies and technologies plays a major role in mitigating and reducing the greenhouse gas emissions.

Impact of Climate Change on India's Agriculture:

Monsoon is the key factor where the Indian agriculture depends upon from the ancient times. Changes in the monsoon trends and increase in temperature can have a drastic impact on the agriculture sector. These monsoon changes can primarily affect the Indo Gangetic plains in terms of wheat crop. It has been seen that in the states of Odisha, Jharkhand and Chhattisgarh have faced a huge loss in the production of rice due to severe drought with an estimation about \$800 million. It has been noted that with an increase in the level of co₂ to 550pm can increase the production for the crops that includes rice, wheat and oilseed with a rise from 10 to 15 % whereas if we see in terms of temperature, 1°C rise can affect the crop production in a negative way by reducing its yield from 3% up to 7% for the crops

that includes rice, wheat, maize and oilseeds. There would a decrease in the marginal productivity by 2020 and by 2100 with the increase in temperature levels and rainfall variability (10%-40%) there would an automatic fall in the production of crops. In a country like India, Rainfall has a directly related to monsoon that is originated from the Indian and Arabian seas. Hydrological cycle helps in accelerating a warmer climate which in turn influences the rainfall. There would be a substantial increase in the surface moisture evaporation when the warm air tends to hold moisture. For example, in the arid regions of Rajasthan, ET known as evapotranspiration had increased up to 14.8 % with rise in the temperature. With a slight increase in ET due to global warming can act as a major reason for affecting the fragility of water resources in the ecosystem of Rajasthan. Changes in the climate fluctuation will have an impact on the ground water recharges, frequency of flood and drought and most importantly the soil moisture plus the ground water level. It has been found out the effect of climate change will have an impact on the water cycle where there would be an increase in the sea level with leading to the risk of permanent damages over ground water and rivers, which is ultimately used in both for agriculture as well as industrial uses.

YEAR	Annual change in carbon dioxide (CO₂) emissions in India from 1982 to 2020 (in million tonnes) *
2005	72
2006	32
2007	91
2008	88
2009	86
2010	74
2011	24
2012	99
2013	127
2014	27
2015	149
2016	74
2017	43
2018	123
2019	132

Source: <https://www.statista.com/statistics/1119152/annual-carbon-dioxide-change-in-india>.

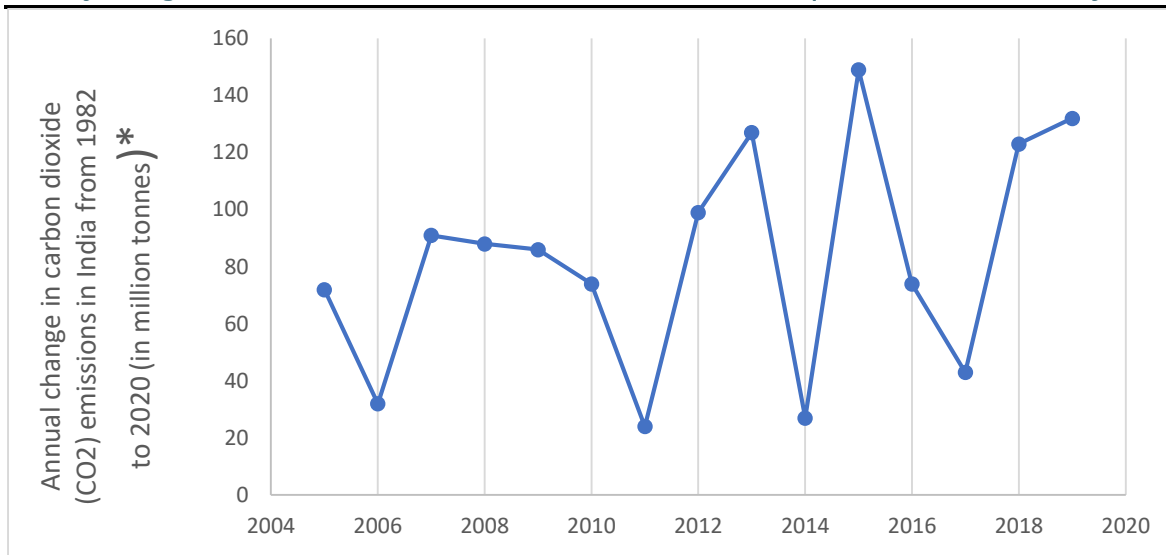


Fig1

From this figure we can indicate that there is an increase in carbon dioxide over these years ultimately influences the climate change. Higher the CO₂ can have a bad effect on the crop yield by reducing the level of output. Some of the studies show that carbon dioxide can also be a reason for increase in the growth level of plants. But other factors that shows change in the temperature level, ozone, nutrient and water constrains can stand as a barrier to increasing yield production. For instances if the temperature level increases mean stronger heat waves that is beyond the limit it may affect the crop yield and rise in the level of CO₂ can be a reason for the crop to lose its nutrients such as protein and nitrogen with the fall in the quality level. A reduction in the quality of grain and forage can reduce the ability to pasture in order to support the livestock. Since CO₂ and temperature are interlinked, prevention of crop growth occurs with rapid rise in the temperature and precipitation during the extreme events of floods and drought. It becomes very difficult challenge to cope with the droughts especially during summer rising temperature because soil tends to be drier. In some of areas irrigation facilities can come in handy but other places may be under the situation where the water availability is very less for irrigation facilities that needed more. Pests, fungi and weeds comes in more during the time of warmer temperatures, wetter climates as well as increase in the level of carbon dioxide. There would be an increase in these pests and weeds during the period of climate change that can pose a greater challenge to the farmer crops that are not previously known with the species. Rising in the level of carbon dioxide can help in the growth of plants but reduces the quality and the nutritional level in most of the crops leading to fall in the productivity. It reduces most of the important components of nutrients such as proteins and minerals in almost in every plant species that includes rice, soyabean and wheat. This effect on the crop can act as a threatening agent to human being's health. Increase in the use of pesticides can reduce the pest pressure from the chemicals used can have a severe impact on the human population.

Period	Average Temperature
1961-70	25.44
1971-80	25.46
1981-90	25.56
1991-2000	25.73
2001-10	25.73
2011- 18	25.84

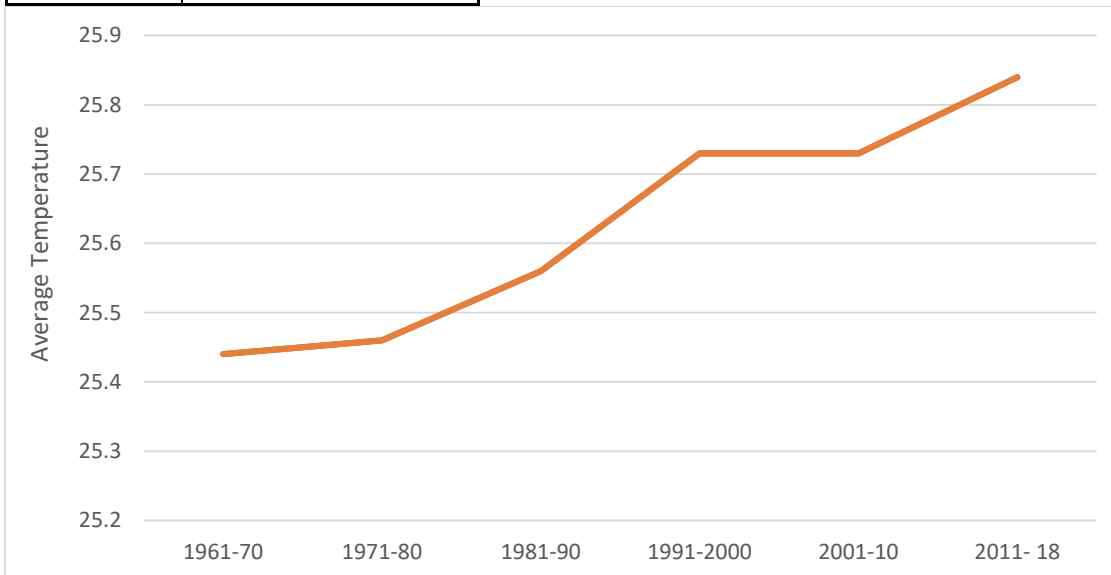


Fig 2: Source: Environmental Statistics 2019, MOSPI.

From this data we can see the temperature is keeping on increasing as years pass by. So, from this data we can inquire that rising temperature with changes in the precipitation patterns can have severe impact on the agricultural crops. The productivity will be hampered to do a great increase in the carbon dioxide emission. The vulnerability of the landless and poor increases due to these changes. From the recent analysis, it is represented with the fact that higher temperature is going to affect the agriculture sector in the lower latitudes where most of the poor population live. So, in order to make it more resilient towards agriculture, better management of natural resources should be done to bring in positive changes in the economy. So, India has come up with National action plan mission such as focusing on solar energy, conserving water, sustainable agriculture, a strategic platform for climate change, rain water harvesting, revival of water bodies and other conservational technologies.

Factors affecting the Food Security

Food security is linked directly as well as indirectly to climate change. Any fluctuation or alteration in the parameters of climate change can have a greater impact on the crop growth and affect the quality of the food being produced. When it comes in terms of indirect linkages, it is mostly based on floods and drought that can lead to a huge loss, leaving big patches of arable land being unfit for cultivation and thus having a negative impact on the food security. So therefore, the total food security will have an impact when there is an environmental change and taking steps to cope up from these changes. Climate change as a whole affects the agriculture sector, as it is going to create a situation where there would be a fall in food production with an increase in prices contributing towards food insecurity. Food insecurity can act as an indicator for the extreme climatic events and changes. Due to the rise in the temperature, global warming can affect with greater consequences in relation to the agriculture production and trade in every developing country with a rise in the risk of hunger. There has been a rise in the chronic hunger from 800 million to 1 billion overall. There would be a rise of 9.1 billion of hunger population by the year 2050 which was started by United Nations population data and projections (UN 2009). IPCC

Scarcely alarmist stated that a rise in the winter temperature to 0.5 degree Celsius will lead to a reduction of 0.45 per hectares yields. Since the majority of the Indian agriculture depends upon wheat and rice, if any changes in their growth pattern can impact the food security. Since 1995, about 2.56 lakh farmers have committed suicide. According to the census of the Indian Council of Agriculture Research have estimated that there would be a fall in the crop yields from 4.5% to 9% by the 2039 and 25 % by 2099 due to climate change. It has a big impact on food security and is marked in the number of ways. It impacts the livestock, the crops, fisheries, and aquaculture. An increase in the energy prices due to climate change mitigation efforts can cause food to be more expensive in a given period. Due to rise in the use of crop water and drought, it has led to the fact that water is essential for food production but is in scarce situation. Since there are certain areas which are climatically unstable for any production, competitiveness increases for those lands where the productivity rises up. In addition to this scenario, extreme cases of weather condition indulged with the climate change can reduce the agriculture productivity by increasing the prices. One such example shows that in the year 2010, strong summer heat waves led to a greater loss in the yields with drastic increase in the prices of staple food. This increase in the prices for staple food has pushed people towards poverty which shows the influence of climate change moving towards a situation of food insecurity. Russia, Ukraine and Kazakhstan were majorly affected. With an overall estimation about 27.5% of the population is still below the poverty line it is essential to reduce the cause of vulnerability due to the impacts of climate change. Every year there must at least be a 5% increase in the production to keep up with the pace of growing hunger to ensure food security in the economy. A careful management of resources like water, soil and biodiversity are required in order to the challenge faced due to climate change and to monitor the changes regionally and globally

Policies implemented to cope up with the challenges of climate change:

The challenges of climate change have been taken into consideration for formulating the policies to reduce the risks factors by the international community and government. India has been trying to connect a balance shade between growth and sustainability in every developing country by placing agriculture as an important area in every negotiation. The NAPCC (National Action Plan on Climate change) has focused on making Indian agriculture sustainable by coping up the risks cause by climate change. In order to enhance the resilient features of the agriculture sector, the Indian Council of Agriculture Research came up with the idea of Climate Resilient Agriculture project to bring in changes in terms of technological demonstration here referring to achieving climate resilient agriculture by enhancing adaptive capacity of the farmers, strategic research and making a strong capacity building in the system. Important groups such as Climate Change, Agriculture and food security (CCAF) and Consultative Group on International Agriculture Research (CGIAR) are promoting to bring in Resilient agriculture and food system in many countries especially in a country like in India to cope up with the challenges. Some of the climate smart technologies such as building up smart villages with proper water shed management in improving natural ecosystem for rural people, farm systems approach by building resilience economy with better climate information and meteorological advisory has been developed by ICRISAT (International Crops Research Institute for the Semi - Arid Topics). It is important to note that Climate smart Agriculture should be inculcated by all the makers to build in resilience economy by providing proper training to the officials so that they can understand the impacts of the climate changes at global, regional and local levels. A very well-defined institutional structure should be maintained so that government can a keep a good track on programs and schemes for better sustainable practices. With allocation made by MGNREGA, can help in setting up climate proofing projects such as soil and water management, implementing farm ponds, plantation and agro- forestry, plus other activities that are ecofriendly which could be adapted for building up a resilience agriculture economy to climate changes. Government both at state and central level should act as a funding support system to implement new technologies and solutions that can suit up to the local crops and ecology towards the complex situation of climate variability. Especially those farmers should be provided with better insurance product who are small holders and are often kept separated from the agriculture

community. This would act as a safety net to the farmers. Other technologies such as pest surveillances, simulation model, analytics of big data is also considered important for better agriculture practices. Use of ICT can play an important role in adapting to the climate smart interventions. In order to reduce the greenhouse emissions India came under a legal binding agreement on climate change known as the Paris agreement where the country submitted its climate actions (Nationally determined Contributions) in the motive to get adapted to friendly climatic practices with better capacity building, technological development by achieving net zero greenhouse gas. For the country to be sustainable and to achieves zero hunger goal, government should act upon the schemes and agriculture friendly practices which would automatically increase the income of small farmers who are the most important section of the society who get effect of the climate change

Policy Implication:

Some of the policies that can be inculcated are as follows

1. There is a need for spreading up irrigation facilities because most of the land are less irrigated because they are under backdrop in ground water reserves.
2. Second there should be a step up in the research agriculture technologies as it would help in developing varieties of crop with better implementation of cropping techniques.
3. Subsidize the use of fertilizers and pesticides with proper management of water resources that would help in increasing the productivity overall.

Final Conclusion:

Agriculture sector is considered to be one of the most important sectors in the India economy. Half the population is dependent on it directly and indirectly. It has been seen that India accounts about 7.4% to the total Agriculture output. In a country like India, agriculture sector is more prominent and vulnerable towards the changes in climate. These climatic changes take place because of increase in the temperature that is due to the emission of greenhouse gas effect. As the result there is a fall in the crop production making the economy not self-sufficient when it comes in terms of food security. Most of the people with lower income are affected by it. Most of the important consequences is about bringing better quality and quantity to never ending demands of the people for food production. Higher temperature is the reason for more increase in pests and weed. As a result, destroying the whole production activity. Not just this but since climate is directly linked to food production across the globe, there might be fluctuation leading to positive and negative effect. The net food production will fully be based on the environmental factors changes. So, the government came up with various policies and scheme to cope up the risk of climate changes where one of them being in the legally binding treaty to reduce greenhouse gas emission. so, by the year 2025 India has targeted to reduce the greenhouse gas emission. so, coping up with challenges of climate change can be done by better management of resources like soil, water and biodiversity.

Therefore, it is important to bring up changes with coordinated efforts with better research and climate information, improved technologies will not only help the economy to cope with the challenges but also dedicated efforts will bring in changes that can be acted upon the factors that include agriculture, forest, animal husbandry, aquatic life and other living beings.

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