

CLIMATE CHANGE AND RURAL DEVELOPMENT: IMPACT OF CLIMATE CHANGE ON MARGINALIZED FARMERS IN INDIA

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ABSTRACT

An attempt has been made to study both, the advantages and disadvantages, of climate change on the Indian agricultural sector with special emphasis on the marginalized farmer. Climate change in today's world is a very real concept. All nations can already feel its impact in terms of unprecedented floods, droughts, melting of glaciers, extreme cold, and extremely hot temperatures, along with precipitation. This is going to have an adverse impact on future generations unless the world gets together and decides to work as one in reducing the impact of this universal phenomenon. This paper, in particular, tries to understand the impact of these changes on the Indian agricultural sector in India, and in particular, the marginalized farmer. The government has to make a concerted effort in research and development concerning seeds, water conservation, saving of scarce resources, and upliftment of income of the marginalized farmer to help him move out of poverty.

1. Definition of Climate Change

Climate change refers to changes in the average atmospheric and environmental conditions of the earth caused due to natural, as well as artificial causes. Natural causes include changes in

1. solar activities
2. melting of ice caps
3. volcanic eruptions
4. ocean water temperature
5. winds

Artificial causes include impacts of human activities like

- deforestation
- depletion of the ozone layer
- greenhouse gas (GHG) emissions (27% of which come from agriculture, forestry, and land-use change).

An increase in GHG emissions of gases like carbon dioxide (CO₂), methane, and nitrous oxide, from the time of the Industrial revolution in the mid 20th century, followed by an increased use of fossil fuels, has led to global warming (increase in average temperature of the globe). Global warming also causes a rise in the occurrence of floods, heat waves, droughts, typhoons, and hurricanes, along with a change in patterns of precipitation and temperature. Impacts of increased global temperatures are also seen through decrease in glaciers, changes in plant and animal habitats, a shorter winter season, early arrival of spring season, and a rise in ocean temperature. There has been an increase in the temperature at the poles, which accelerates the melting of the ice-caps, causing a significant rise in sea level. If emissions continue to rise at the current rate, by the end of this century, the global average temperature could increase by 2.6–4.8°C and sea levels could rise by 0.45–0.82 meters.¹

These changes in the ecological systems impact all forms of life on the planet. To prevent severe impacts of climate change, rapid and far-reaching solutions are required to limit the rise of temperatures to 1.5°C. There must be a substantial and sustained reduction of GHG emissions which means drastic measures to be taken both in the agricultural and the industrial sector.

2. General Impact of Climate Change

Climate change causes changes in temperature, precipitation, sunlight, etc. in the agricultural sector. Firstly, the impacts on the arable and livestock sector are made known by the biological changes including changes in blooming and sowing seasons, and changes of areas that are suitable for cultivating crops. It also impacts the entire agricultural ecosystem by giving rise to new pests and blights (plant disease) and changes in biodiversity. In the livestock sector, there are changes in fertilization and breeding seasons and changes in the growth of pastures. Secondly, the hydrology sector is impacted as there are changes in the underground water level and temperature, flow of rivers, and quality of marshes and lakes. This happens due to the change in precipitation, evaporation and soil moisture level. Climate change is also projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions. Each degree of warming is expected to decrease renewable water resources by at least 20% for an additional 7% of the global population.

The impacts on the arable and livestock sector cause changes in productivity of the agricultural sector, and the impacts on the hydrology sector cause a change in the agricultural infrastructure as there are changes in the availability of water.

Global warming has positive, as well as negative impacts on the agricultural sector. It has been seen that CO₂ (carbon dioxide) increases plant growth, but ozone reduces growth. The reduction in ozone levels, therefore, has to be an important aspect to look into. Adverse impacts are projected for key cereal crop production, high-value export agricultural production, and intensive animal husbandry practices. But positive impacts are projected for some tropical crops. Staple crops such as wheat, maize, and rice are already experiencing reduced crop yields, increased price volatility, and reduced quality in some parts of the world. The likeliness of an increase in price volatility results from uncertainty and an increase in the cost of production due to changes in resource availability. Food quality is impacted as growing wheat, rice, barley, or potato in high CO₂ concentrations reduces the protein content by 10–14%. On the other hand, crops like coffee, tea, and cocoa are likely to experience increased production. Without adaptation, the local temperatures would further increase and crop yields would be reduced to an even lower level. Disastrous impacts would also be felt through increases in irrigation demand as well as the increasing incidence of agricultural pests and diseases. Rising land temperatures and increased intensity of heat may lead to pest and disease outbreaks which could lead to adverse food production. Negative impacts of global warming also include-

- reduced crop quantity and quality due to the reduced growth period following high levels of temperature rise
- reduced sugar content, bad coloration, and reduced storage ability in fruits
- increase of weeds, blights, and harmful insects in agricultural crops
- reduced land fertility due to the accelerated decomposition of organic substances
- increased soil erosion due to the increased rainfall.

The positive impacts of global warming include-

- increase in crop productivity due to fertilization effect caused by the increase in carbon dioxide concentration in the atmosphere
- expansion of the areas available for the production of tropical and/or subtropical crops
- expansion of two-crop farming due to the increased cultivation period,
- reduction of damages to winter crops by low temperature,
- and reduction of heating cost for agricultural crops grown in the protected cultivation facilities

Complex interactions between CO₂, ozone, mean temperature rise, temperature extremes, reduced water availability, and changes to the nitrogen cycle exist, whose overall effect is difficult to predict.

The carbon neutrality target which was set by India at the CoP26 conference (the 2021 United Nations climate change conference, held at the SEC center in Glasgow, Scotland, United Kingdom), has led to the Indian Union budget for 2022-23 to take serious action concerning climate action and energy transition.

3. Impact of Climate Change on Indian Agriculture

Indian agriculture contributes 73% of the country's methane emissions. India has not agreed to follow the EU-US pledge to slash methane emissions by 30% by 2030 despite India being the world's third-largest emitter of methane. The finance minister did speak of free natural farming for five kilometers along the river Ganga. Besides, greater emphasis was on millet and oilseed production to control toxic emissions. But these measures are not enough to reverse the damage that has already taken place. The damage is basically due to the excessive amount of subsidies that the government provides to the agricultural sector with respect to urea, canal irrigation, and power for irrigation, as well as the minimum support prices (MSP) and procurement policies, that are concentrated in a few states and for a few crops. The states are primarily, Haryana, Punjab, and western Uttar Pradesh, and the crops primarily are rice and wheat.

Rice stocks with the food corporation of India (FCI) are seven times the buffer norms. (2021) This is in spite of the fact that exports of rice were allowed and that a large amount was distributed through the PDS (public distribution system). The value of rice lying in the FCI godowns is worth close to 2 lakh crores. The extent of GHG embedded in these stocks is huge. According to the national GHG inventory, the agriculture sector emits 408 MMT (million metric tonnes) of carbon dioxide equivalent and rice cultivation is the third-highest source. Paddy fields emit atmospheric nitrous oxide and methane which is 80 to 83 times more powerful than carbon dioxide emissions, which could be a powerful factor in driving the temperatures up. The amount of methane that is emitted from paddy fields is equivalent to 71.32 MMT of carbon dioxide.

India does not report nitrous oxide emissions which are equally detrimental to the atmosphere. Nitrous oxide is not part of the GHG parameter. If this is included, the adverse impact on the climate would be much worse than what has been stated. We see then that lowering methane emissions does not necessarily mean lowering net emissions. The other factors which are not taken into account in the GHG parameter are the emissions that arrive due to the burning of rice residues, application of fertilizer, production of fertilizer for rice, energy operations like

harvesting, pumps, processing, and transportation. The IMF (international monetary fund) states that a carbon tax should be imposed such that the world would be in a position to reduce temperatures by 2 degrees Celsius. India does not have a carbon tax being imposed on the agricultural sector as yet.

Besides GHG emissions another factor that is of concern is overexploitation of groundwater resources, particularly, in the northwest and some parts of southern India. This again is primarily due to paddy cultivation. In the initial years after India's independence, there was a dire need to be self-sufficient in food and to have enough food security for its citizens. But, given this scenario today, where there are excess buffer stocks, and there is enough food security, the time has come to concentrate on reduction in GHG, and nitrous oxide, as well as to control the exploitation of groundwater. An attempt should be made to reward farmers in cash, for switching from carbon-intensive crops such as rice, to low carbon-intensive crops, and to switch to farm practices that lower GHG emissions. Such a move will give India, a climate-smart agriculture. Along with this, if productivity levels are also protected, then we would be in a position to access the global market.

The impact of temperature and rainfall is felt when temperatures are much higher and rainfall, significantly lower, and also when days without rain are much more than normal. Climate change could in fact reduce yearly agricultural incomes from 15 to 18 percent on average and this may go up to 20 percent for unirrigated areas.

Before 2017, the agricultural sector has witnessed farm revenues that are declining for several crops, although production is increasing and market prices are falling below the minimum support price (MSP). Agriculture would have to move towards the situation where productivity would have to be increased, price and income volatility be reduced, against increasing resource constraints.

The factors that impact agriculture are-

- 1) Shortage of water and land
- 2) Deterioration in soil quality
- 3) Impact of Climate change on
 - a) temperature increase
 - b) rainfall variability.

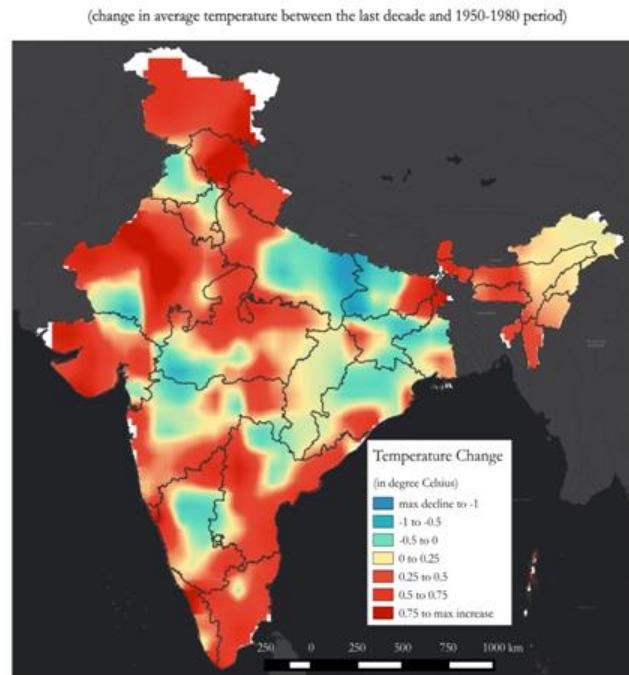
4. Impact of Climate Change on Marginalized Farmers in India

As we know, the agricultural sector is important for economic reasons as it still contributes close to 16% of GDP and employs 46% of the workforce. Poor agricultural performance can have a detrimental effect in terms of inflation, farmer distress, and unrest, leading further to political and social ramifications in the course of its industrialization. All of which can prevent the economy from achieving its goal of sustainable economic growth. Sustainable economic development is the movement of the population dependent on agriculture to the manufacturing and servicing sector, along with this, the contribution of agriculture to GDP reduces over time. The reason is that historically, agriculture cannot achieve the sustainable living standards that the manufacturing and services sectors can. This does not reduce the importance of the agricultural sector as it has to provide greater food supplies, rising farm incomes, along with the accumulation of human capital. Thus, all good successful policies concerning economic and social development in India, imply increased urbanization and productivity in other sectors of the economy. India which is agrarian in nature represents diverse climate zones so what is required is disaggregated cross-country data. The broad pattern post-1970s which is common to both the rabi and the Kharif seasons indicates an average increase in temperature by about 2% between 1970 and the recent decade. In the same period, the Kharif rainfall has declined on average by 26 mm, rabi rainfall by 33 mm, and annual rainfall has declined by 86 mm.

The positive impacts bring their own set of opportunities and the negative impacts cause increase in costs. Therefore, we need solutions that can maximize these opportunities and minimize the costs on the path to sustainable agriculture development. To counter food production changes, there would have to be increasing expenditure on refrigeration, processing, transporting, and retailing.

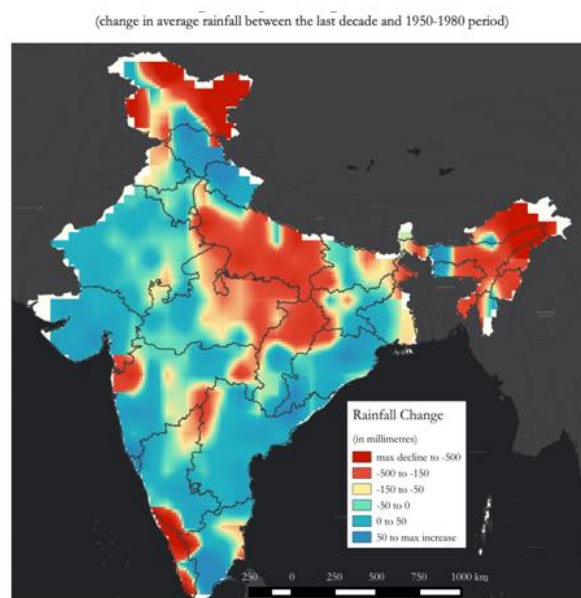
Weather is a very important input for the agricultural sector and it seems to concern developing countries more because these countries are highly dependent on this sector². Looking at the cropping patterns of kharif and rabi, we find that the impact of temperature and rainfall is highly skewed. The adverse impact is felt when temperature increase is extreme and shortage of rainfall is acute. These shocks are felt in both irrigated and unirrigated areas. The impact being more on the latter. In the case of kharif yields, in unirrigated areas, it would be 10% lower in the case of abnormal temperatures and as far as rainfall is concerned, the kharif yields would be 18% lower. In the case of rabi yields, unirrigated areas indicate a 4.7% decline.³ This can be seen in the figures shown below.

Figure 1: The impact of temperature and rainfall on various states in India



Source: Survey calculations from IMD data.* Red (blue) denotes rising (falling) temperature.

Figure 2: impact of changes in rainfall



Source: Survey calculations from IMD data. Red (blue) denotes decreasing (increasing) rainfall.

Unirrigated areas are defined as those districts where less than 50% of cropped area is irrigated. Besides, the irrigated and unirrigated area, what is also important is the timing of rainfall. Also apparent is the susceptibility of different crops to temperature and precipitation. The clear pattern that emerges is that crops grown in rain-fed areas pulses in both Kharif and rabi—are vulnerable to weather shocks while the cereals—both rice and wheat—are relatively more immune. Looking at the area from 2004 to 2014, the impact of rainfall shocks on yields remains unchanged but what is more important is the temperature shocks. Is this a one-off phenomenon, or the start of a new long trend with an adverse impact on Indian agriculture?

These rainfall and temperature changes that have occurred can be translated in terms of impact on farm incomes. Extreme temperature shocks can reduce farmer incomes by 4.3% and 4.1% during Kharif and rabi respectively whereas extreme rainfall shocks reduce incomes by 13.7% and 5.5%. But the impact on unirrigated areas is even worse.

The question that arises is in which direction should farm revenues move as reduced yields lead to lower supply and higher prices. The farmer benefiting in such a situation is the rich farmer.

Indicated below are two tables showing the impact of weather shocks on agricultural yields and farm revenue. (Indian economic survey tabled in 2017).

Table 1. Impact of Weather Shocks on Agricultural Yields
(percentage decline in response to temperature increase and rainfall decrease)

| | Extreme Temperature Shocks | Extreme Rainfall Shocks |
|---------------------|----------------------------|-------------------------|
| Average Kharif | 4.0% | 12.8% |
| Kharif, Irrigated | 2.7% | 6.2% |
| Kharif, Unirrigated | 7.0% | 14.7% |
| Average Rabi | 4.7% | 6.7% |
| Rabi, Irrigated | 3.0% | 4.1% |
| Rabi, Unirrigated | 7.6% | 8.6% |

Source: Survey calculations.

Table 2. Impact of Weather Shocks on Farm Revenue

| | Extreme Temperature Shocks | Extreme Rainfall Shocks |
|---------------------|----------------------------|-------------------------|
| Average Kharif | 4.3% | 13.7% |
| Kharif, Irrigated | 7.0% | 7.0% |
| Kharif, Unirrigated | 5.1% | 14.3% |
| Average Rabi | 4.1% | 5.5% |
| Rabi, Irrigated | 3.2% | 4.0% |
| Rabi, Unirrigated | 5.9% | 6.6% |

Source: Survey calculations from IMD & ICRISAT data.

The marginalized farmer is defined as a farmer who has a bare subsistence level of income from his or her land and most of the time works as agricultural labor to supplement his income. These farmers, normally have less than 2 hectares of farmland and they comprise close to 86.2% of the country's total farmers. Most of these farmers in reality have only up to 1 hectare.

They are the ones who do not have access to hoarding and cannot wait to sell their products till the price is high. Most of them are not in a position to take advantage of the shortage of supply which leads to higher incomes. It is the rich farmer who is in a position to take advantage of revenue increase because of adverse climate change. In a year when the rainfall levels were 100 mm less than the average, farmer incomes would fall by 15% in the Kharif season and by 7% in the rabi season.

A study by the IMF in 2017 finds that in emerging market economies, in particular, a 1 degree Celsius increase in temp would reduce agricultural growth by 1.7%, and a 100 millimeters reduction in the rain would reduce growth by 0.35%.

This would differ from country to country and may not be true for India, especially, in the unirrigated and for the marginalized farmers.

Figure 3: spread of irrigation over the years

Figure 3(a): irrigated proportion (1966)

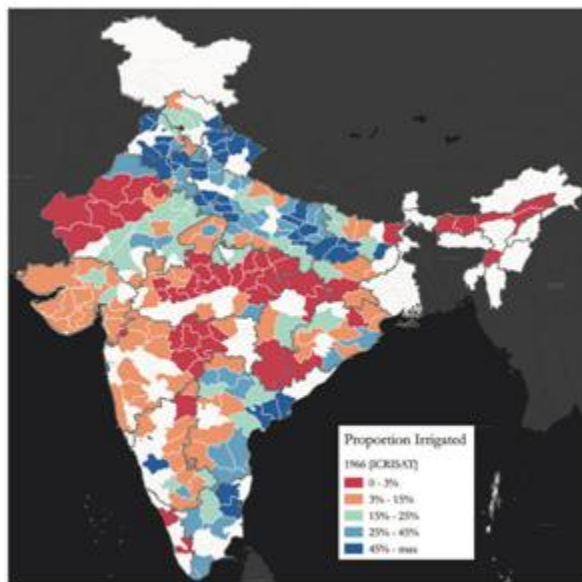
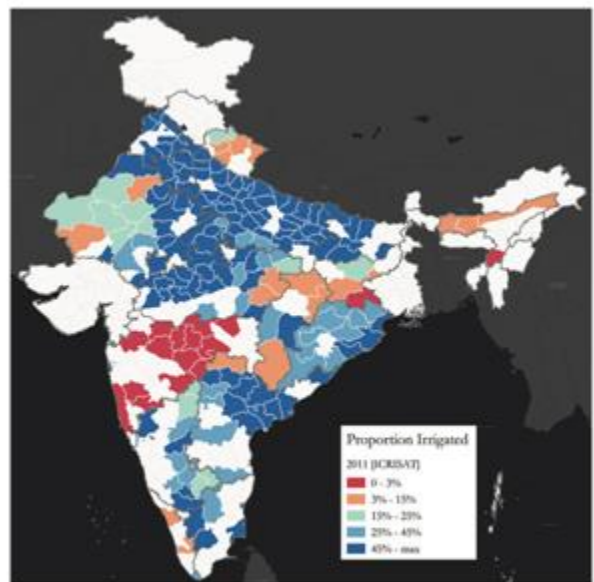


Figure 3(b)- irrigated proportion (2011)



Source: Survey calculations from ICRISAT data.¹⁵

In the absence of any adaptation by Indian farmers and any changes in policy with respect to irrigation, farm incomes are going to be lower by around 12% on an avg in the coming years and amongst them, the unirrigated areas and the marginal farmers are going to be even more adversely impacted.

Models of climate change have indicated an increase in variability of rainfall in the long run. This implies a simultaneous increase in both the number of dry days as well as days of very high rainfall. Thus, climate change would impact farm incomes through

- increase in average temperature
- decrease in average rainfall
- increase in dry days
- increase in the number of wet days.

All of them are correlated and the total impact of this is not a simple arithmetic sum of all individual effects.

It has been seen that one cannot negate the other. These impacts do not offset each other, in fact, they are additive. Farmer income loss from climate change could be between 15% and 18% on average, rising to anywhere between 20% and 25% in unirrigated areas and may be worse for marginalized farmers.

5. Suggested solutions for India

The lesson for India is that it has to spread irrigation, and this has to be done against a backdrop of rising water scarcity and depleting underwater resources. States like Karnataka, Maharashtra, Rajasthan, Madhya Pradesh, Jharkhand, and Chhattisgarh are extremely vulnerable to climate change on account of not being well irrigated. While the Indo-Gangetic plains are well irrigated.

The challenge here is that India would be attempting full irrigation against the backdrop of water scarcity and limited efficiency in existing schemes. The answer may be in using new technology like drip irrigation and water management which has been captured in the “more crop for every drop” campaign and it may hold the key to future Indian agriculture (Shah Committee Report, 2016; Gulati, 2005) .

Another factor that has to be taken into account is research and development in the agricultural sector is that area which will counter the adverse impacts of a rise in mean temperature. Agriculture should not only be concentrated on increasing yields but also attempt to work towards finding solutions, resulting from the disadvantages arising out of climate change.

Research has shown that pulses and soya beans are most vulnerable to weather and climate. Climate change will increase farmer uncertainty, the government could help by introducing crop insurance. This would be built on the current crop insurance schemes that are available to the farmers issued by the government (Pradhan Mantri FasalBima Yojana). Drones could be another research invention that could aid the farmers.

In India, there are two sets of agriculture.

1. well-irrigated areas where the price and procurement policies exist (basically in north India). Subsidies need to be relooked such that efficient resource allocation is encouraged. A better way of helping the farmers would be in the form of direct benefit transfers.

2. agriculture prevalent in India in central-western and southern parts are still dependent on rain. Thus, these states have inadequate irrigation, inadequate procurement, insufficient investment in resources and technology for products like pulse soybean and cotton, and weak policies with respect to livestock.

6. Conclusion and Important Policy Direction

In conclusion, we find that the impact of climate change on the Indian agricultural sector is going to adversely impact the unirrigated areas and more so the marginalized farmers. A reduction in 1 to 2 degrees temperature along with extreme weather conditions with respect to rainfall and precipitation are going to negatively impact the production of cereals, pulses, soybean, oilseeds grown both in northern and the rest of India. In the northern region which is well irrigated, care should be taken to reduce subsidization of scarce resources, allow market forces to decide the price and if benefits have to be given then it should be in the form of direct benefit transfers. The policies that should be followed, in the rest of India, is different as this supports the unirrigated, more marginalized, more poverty-stricken, higher dependency on rainfall area. The policies should be concentrating on researching and developing new methods for seeds, drip irrigation, extension of irrigation, reduction in dependency on weather. besides this, greater excess to market, better infrastructure, higher credit facilities, increasing spread of crop insurance. The impact of climate change seems to be alarming as indicated by the latest report from the Intergovernmental Panel on Climate Change (IPCC) which has been released on 1st March, 2022. This states that humans and natural ecosystems have been pushed beyond their adaptation limits. India, being highly vulnerable, will have to cut across sectors and regions to reduce economic losses and damage to lives and biodiversity. This would require political will and administrative implementation from panchayat to state and national levels (Roxy Mathew Koll, Times of India, 1st March, 2022). The adverse impact of climate change will have to be taken seriously considering that the worst-off sections of society are the ones that are most affected.

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