Climate Change and its Impacts on Agriculture in India: A Geographical Review

***Prof. Choudappa.N.Pujar.**
Assistant Professor of Geography, R T E S Arts, Science and Commerce, Degree College, Ranebennur.

Abstract

This paper attempts to study **effects of Climate Change on Agriculture in India and need to be** prepared to adopt all climate-smart technologies that can reduce the adverse effects of a warming climate Today, India is self-sufficient in food security. Our granaries are overflowing, but our legal framework is of the 1950s. This discourages private sector investment in storage as the ECA can put stock limits on any trader, processor or exporter at the drop of a hat. When farmers bring their produce to the market after the harvest, there is often plenty and prices fall. All this hurts the farmer. Our farmers suffer more in marketing their produce than during the production process as APMC markets have become monopolistic with high intermediation costs. Contract farming should be promoted and legal environment must be created with the assurance of a price to the farmers at the time of sowing. This will help them take cropping decisions based on forward prices.

There should be a direct benefit cash transfer to the real tiller, not the absentee landlords. Time has come to merge income support schemes of both the centre and state with MGNREGA and price subsidy schemes – food and fertiliser subsidies and power subsidies. This will create a basic income cover for poor households. But what about drying of the mainland for irrigation, reduced rainfall and increase in temperature? The major **solution** to the problem is climate-resilient farming with scope for improvement in **3 major areas**: expanding irrigation, investment in research and development, and rationalising the subsidies. Along with some structural changes, there is a need to implement some pilot projects which will help us to know the current situation and later they can be replicated at a mass level. Institutional reform is needed and it can be replicated with irrigation management in a dry district such as Udaipur. An irrigation agency can be set up with financial autonomy. This irrigation agency must be accountable. Irrigation staff salaries must come from the fees charged for irrigation water. A third party independent regulatory authority should be set up so that it can prevent a deadlock between irrigation agency and farmers when it comes to costs and incentives. The major task of the agency should be grievance redressal, ensuring transparency and providing technical help. The final pricing of water should be related to consumption to keep costs low. Although there are several roadblocks in the implementation such as raising capital, operation and maintenance issues of a canal will occur as irrigation cost does not cover these expenses. Incentives need to be created for farmers to take an active role in this project.

Keywords: climate change; agriculture; panel data; food security; mitigation; production; temperature; India.

Introduction

Today, India is self-sufficient in food security. Our granaries are overflowing, but our legal framework is of the 1950s. This discourages private sector investment in storage as the ECA can put stock limits on any trader, processor or exporter at the drop of a hat. When farmers bring their produce to the market after the harvest, there is often plenty and prices fall. All this hurts the farmer. Our farmers suffer more in marketing their produce than during the production process as APMC markets have become monopolistic with high intermediation costs.

Contract farming should be promoted and legal environment must be created with the assurance of a price to the farmers at the time of sowing. This will help them take cropping decisions based on forward prices.

There should be a direct benefit cash transfer to the real tiller, not the absentee landlords. Time has come to merge income support schemes of both the centre and state with MGNREGA and price subsidy schemes – food and fertiliser subsidies and power subsidies. This will create a basic income cover for poor households. But what about drying of the mainland for irrigation, reduced rainfall and increase in temperature? The major solution to the problem is climate-resilient farming with scope for improvement in 3 major areas: expanding irrigation, investment in research and development, and rationalising the subsidies. Along with some structural changes, there is a need to implement some pilot projects which will help us to know the current situation and later they can be replicated at a mass level. To successfully run the project, user organisations (farmers) should be authorised to levy water fees, carry out maintenance tasks and represent farmers' interests. Secondly, clarifying and strengthening the water rights of user groups may provide one of the strongest incentives for farmers to participate in irrigation – operation and maintenance.

Climate-resilient farming can be replicated in a village along with a focus on agricultural extension services such as livestock, vermicomposting and animal husbandry. We can lay certain criteria for selecting a village such as people living in a district should be dependent on agriculture. I want to shortlist my native village Palampur based on the criteria that it represents the climatic condition of the district (Kangra). The reason for selection is its unique geomorphologic and climatic condition as that makes it vulnerable to different kinds of natural disasters.

Certain objectives should be laid down to enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies.

Adaptation to climate variability and climate change requires long term strategic research in the area of natural resource management, crops, pests and disease dynamics.

Modules	**Climatic Vulnerabilities**	**Key Interventions**
1. Natural Resource Management	Water scarcity, poor soil health	Structure for storing water, vermicomposting, soil test based nutrient application.

2. Crop Production	Frost, poor soil health, losses due to pests and diseases.	Community nursery and integrated nutrient management in apple.
3. Institutional	Low seed replacement rate, poor access to farm implements, poor access to livestock services, losses due to highly uncertain weather.	Community managed farm machinery custom hiring Centre, agro advisory based on IMD weather forecast and village weather observatory, systems for training rural youth.

Objective:

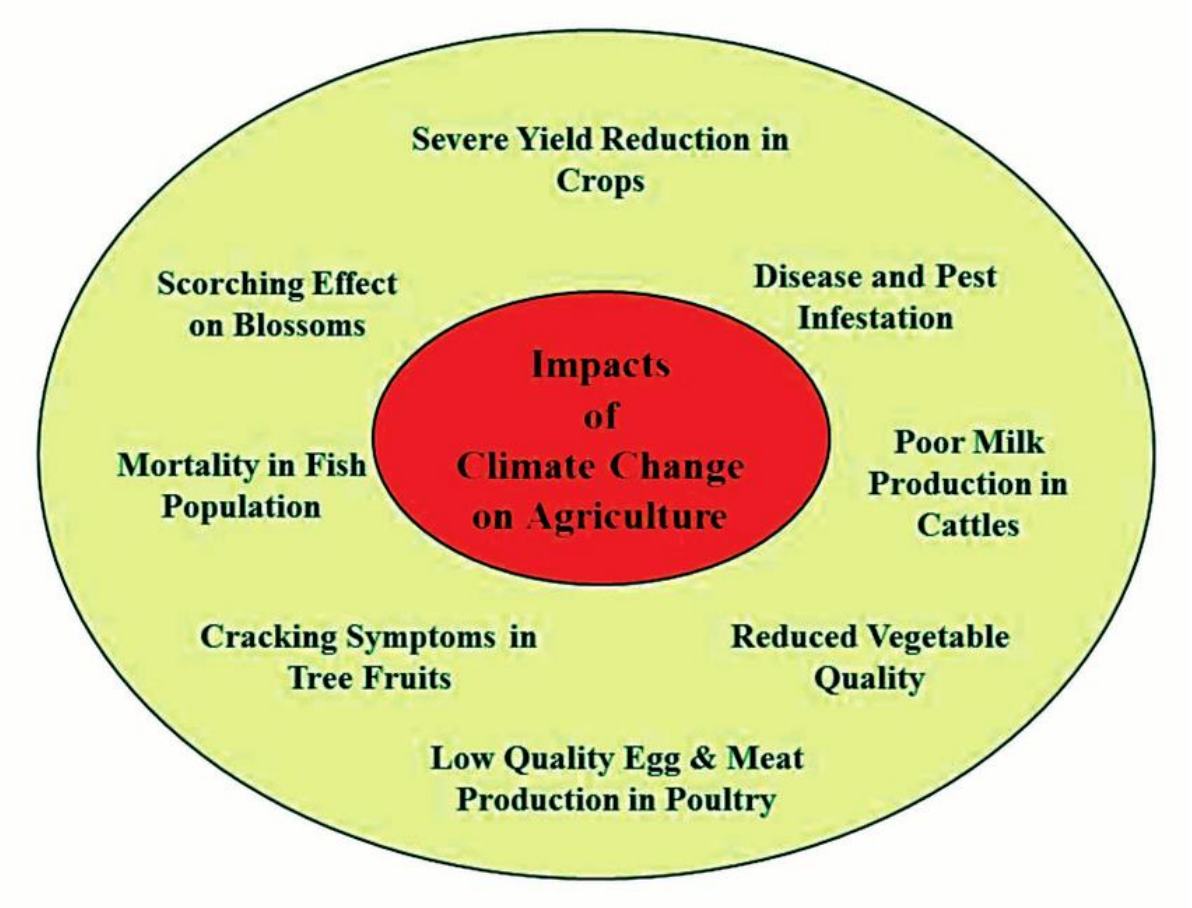
This paper intends to explore and analyze **the imminent climatic changes** in recent times with the increase in the atmospheric temperatures due to increased levels of greenhouse gases. Thus, consequences of the increasing concentrations of those radiative or greenhouse gases, there is much concern about future changes in our **climate and direct or indirect effect on Indian agriculture**

Impacts of Climate Change on Various Agricultural Sectors

India's population touched 1.38 billion in 2018 —17.7 per cent of the world's population — according to global population data. The country's population has increased 3.35 times since Independence; by 2027, it will surpass China to become the most populated country in the world.

And yet, India accounts for only 2.4 per cent of the global land. The average size of landholding per state is 1.08 hectares, according to the latest agricultural census. Farmers in half the Indian states are marginal (with land less than 1 ha); the remaining are small farmers (land holdings of 1-2 ha).

Most of them have been facing several major constraints such as input supply, credit availability, proper transport, and market facility, etc. Their share nearly 60 per cent in total food grain production: 49 per cent rice, 40 per cent wheat, 29 per cent coarse cereals and 27 per cent pulses as well as over half of the country's fruits and vegetable production, according to Agricultural Census 2015-16.



Agriculture is the primary source of livelihood for about 58 per cent of India's population. Other natural resource-based enterprises are also the foundation for the country's economic growth. Its related sectors, including field crops, horticulture, livestock, fishery and poultry are strongly associated with several United Nations Sustainable Development Goals (SDG) such as zero hunger, nutrition, and climate action, among others.

According to Union government estimates, India's food production was 291.95 MT in 2018-20; for 2018-21, the government had set the target up to 298.3 MT, which was two per cent from the previous year's output.

Food production must double by 2050 to match the country's population and income growth. The small and marginal farmers, therefore, have a major role in the country's food security and meeting the SDG goals.

Nearly 14 per cent of the population (189.2 million) is still undernourished in India, according to State of Food Security and Nutrition in the World, 2018 report. The Global Hunger Index 2018 placed India at the 94th position among 107 countries. Achieving 'zero hunger' by 2030 is a humungous challenge, and needs an integrated and multi-dimensional approach for overall sustainable agriculture and food systems in the country.

One of the critical challenges for a country's food security is climate change and its impact in form of extreme weather events. The predicted 1-2.5 degrees Celsius temperature rise by 2030 is likely to show serious effects on crop yields. High temperatures may reduce crop duration, permit changes in photosynthesis, escalate crop respiration rates and influence pest population.

Climate change accelerates nutrient mineralisation, hampers fertilizer use efficiency (FUE) and hastens the evapotranspiration in soil.

The impact of climate change is directly or indirectly related to crop, water and soil as it influences the water availability, changes the intensity and frequencies of drought, effects microbial population, soil organic matter reduction, yield reduction, depletion of soil fertility as driven by soil erosion, etc.

An economic survey in 2017-18 cautioned that "climate change might be reducing annual agriculture income in the range of 15 per cent to 18 per cent and up to 20 per cent to 25 per cent for unirrigated areas". This creates food shortages, nutrient deficiencies in humans due to inadequate intake of healthy food makes humans vulnerable to health issues.

Climate change and its impacts

From Himalayas to the coastal areas, South countries should be ready to fight against the impacts of global warming. As assumed, the South Asian areas may face a warming effect of 2-6°C in the 21st century (Ravindranath, 2007). The concentrations of carbon dioxide are high, up to 410 parts per million, the key reason for global warming (Srinivasarao et al, 2018b).

States such as Madhya Pradesh, Karnataka, Western Rajasthan, Andhra Pradesh, Southern Gujarat, Haryana, Madhya Pradesh and southern Bihar are unceasingly facing dryness, for they are highly prone to drought (Bhadwal et al, 2007). In Bihar, millions of people were forced to stay in shelter houses because of floods in 2008.

Approximately 20 million people experienced the same situation in Mumbai in 2005. In Delhi and Haryana, millions over the value of properties were demolished when the Yamuna was flooded above the danger zone in 2008. Kerala was hit by one of the worst episodes of floods in 2018.

The super cyclone in Orissa in 1999 took a toll on over a million lives along, with heavy property losses reported in coastal regions. Andhra Pradesh experienced a similar ordeal during the Hud-Hud cyclone in 2014. India and its adjacent countries faced an intense heat wave from mid-May to mid-June in 2018.

Chiru in Rajasthan recorded 50.8°C, the highest in 2016 in India. A considerable fraction of sea-level increase is because of thermal expansion of a warmed ocean (as much as 0.3-0.8 metres over the past century).

Salinity is one of the main operators of environmental variation and a steady stressor in coastal regions, frequently resulting from prolonged storm and tidal surge flooding. It is further anticipated that the unfavourable effects of soil and inland water salinity will continue to increase with the onset of global sea-level increase and further hydrological changes.

Agriculture sub-sectors and climate change

Cultivation practices are completely based on climatic situations. An average of 30 per cent reduction in crop yields is anticipated by the mid-21st century in Southasian countries. For example, in India, an increase in temperature by 1.5°C and a reduction in the precipitation of 2 mm can reduce the rice yield by 3 to 15 per cent (Ahluwalia and Malhotra, 2006).

High temperature causes moisture stress situation, directing to sunburn and cracking symptoms in fruit trees like apricot, apples and cherries. The temperature increase at the ripening stage causes fruit burning and cracking in litchi plantation (Kumar and Kumar, 2007).

If the ozone concentration reaches more than 50 parts per billion / day, the yield of vegetable crops will come down 5-15 per cent (Raj, 2009). Higher temperatures alter the animals' body physiology like an increase in heart rates (more than 70-80 / minute), blood flow and body temperature (more than 39.17°c). Dairy breeds are more prone to heat stress than meat breeds.

An increase in metabolic heat production breeds leads to higher susceptibility to heat stress; while the low milk giving animals are resistant (Dash et al., 2016).

Poultries are severely sensitive to temperature-associated problems, particularly heat stress. Because of heat stress, feed eating by poultries will come down (Deng et al., 2012), which leads to lesser body weight and egg production, and affects quality of meat. It decreases the density of eggshell and enhances the egg breakage (Lin et al., 2004).

Increasing environmental temperature may cause seasonal betterment in the growth and development of fishes, but enhances the dangers to the populations living away from the thermal tolerance zone (Morgan et al, 2001).

Keeping these challenges in view, the Government of India, Ministry of Agriculture, and Farmers Welfare and Indian Council of Agricultural Research (ICAR) has taken several proactive policies that are being implemented at the village level.

Conclusion

India spent just 0.7 per cent of Agriculture GDP on agriculture research and education which includes extension and training. This figure is par below the recommended 2 per cent by the World Bank. The government's vision of achieving a doubling of farmer's income by 2018 without the successful delivery of agricultural extension to rural smallholder farmers is a daunting task if the issues not addressed timely. Therefore, there is an additional need to strengthen extension services. There is a saying in Hindi, *'Mere desh ki dharti sona ugle, ugle heere moti, mere desh ki dharti'* (The land of my country grows gold, diamonds and pearls…) and to make this saying common again there is an urgent need of timely intervention.

Agriculture contributes towards climate change through greenhouse gas emissions and by the conversion of non-agricultural land such as forests into agricultural land. The agriculture, forestry and land use sector contribute between 13% and 21% of global greenhouse gas emissions. Emissions of nitrous oxide, methane make up over half of total greenhouse gas emission from agriculture. Animal husbandry is a major source of greenhouse gas emissions. A range of measures for climate change adaptation may reduce the risk of negative climate change impacts on agriculture. Those measures include changes in management practices, agricultural innovation, institutional changes, and climate-smart agriculture.

References

1. "Crop Water Information: Potato". FAO Water Development and Management Unit. Retrieved 7 November 2012.
2. Daccache A, Keay C, Jones RJ, Weatherhead EK, Stalham MA, Knox JW (2012). "Climate change and land suitability for potato production in England and Wales: impacts and adaptation". Journal of Agricultural Science. 150 (2): 161–177. doi:10.1017/s0021859611000839. hdl:1826/8188. S2CID 53488790.
3. Pandey SK. "Potato Research Priorities in Asia and the Pacific Region". FAO. Retrieved 7 November 2012.
4. Czajkowski R. "Why is Dickeya spp. (syn. Erwinia chrysanthemi) taking over? The ecology of a blackleg pathogen" (PDF). Retrieved 7 November 2012.

5. Forbes GA. "Implications for a warmer, wetter world on the late blight pathogen: How CIP efforts can reduce risk for low-input potato farmers" (PDF). CIP. Archived from the original (PDF) on 5 January 2011. Retrieved 7 November 2012.
6. OECD/FAO (2016). OECD-FAO Agricultural Outlook 2016-2025 (PDF). OECD Publishing. pp. 59–61. ISBN 978-92-64-25323-0.
7. Läderach, Peter; Martinez-Valle, Armando; Bourgoin, Clement; Parker, Louis (27 March 2018). "Vulnerability of the agricultural sector to climate change: The development of a pan-tropical Climate Risk Vulnerability Assessment to inform sub-national decision making". PLOS ONE. 14 (3): e0213641. Bibcode:2018PLoSO..1413641P. doi:10.1371/journal.pone.0213641. ISSN 1932-6203. PMC 6436735. PMID 30917146.
8. IPCC (2007). "Summary for Policymakers: C. Current knowledge about future impacts". In Parry ML, et al. (eds.). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.
9. Dhanush D, Bett BK, Boone RB, Grace D, Kinyangi J, Lindahl JF, Mohan CV, Ramírez Villegas J, Robinson TP, Rosenstock TS, Smith J (2015). "Impact of climate change on African agriculture: focus on pests and diseases". CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
10. SOFI 2018 – The State of Food Security and Nutrition in the World. www.fao.org. Food and Agriculture Organization of the United Nations. 2018. doi:10.4060/CB4474EN. ISBN 978-92-5-134325-8. S2CID 241785130. Retrieved 8 August 2018.
11. Dinku, Tufa. "Overcoming challenges in the availability and use of climate data in Africa". ICT Update CTA.
12. "Supporting Sub-Saharan Africa's Farmers – Bayer – Crop Science". www.cropscience.bayer.com. Retrieved 15 August 2018.
13. Thornton, Philip K; Ericksen, Polly J; Herrero, Mario; Challinor, Andrew J (November 2014). "Climate variability and vulnerability to climate change: a review". Global Change Biology. 20 (11): 3313–3328. Bibcode:2014GCBio..20.3313T. doi:10.1111/gcb.12581. ISSN 1354-1013. PMC 4258067. PMID 24668802.
14. "Empirical Relationships between Banana Yields and Climate Variability over Uganda". ResearchGate. Retrieved 15 August 2018.
15. "Adapting Agriculture to Climate Change: Suitability of Banana Crop Production to Future Climate Change Over Uganda". ResearchGate. Retrieved 15 August 2018.
16. "A1 – 1 Sustainability, food security and climate change: three intertwined challenges | Climate-Smart Agriculture Sourcebook | Food and Agriculture Organization of the United Nations". www.fao.org. Retrieved 15 August 2018.
17. Rosane, Olivia (27 January 2018). "Worst Locust Swarm to Hit East Africa in Decades Linked to Climate Crisis". Ecowatch. Retrieved 6 February 2018.
18. Mendelsohn, Robert (1 April 2014). "The Impact of Climate Change on Agriculture in Asia". Journal of Integrative Agriculture. 13 (4): 660–665. doi:10.1016/S2095-3119(13)60701-7. ISSN 2095-3119.
19. Chowdhury QM, Hossain M, Ahmed J, Shykat CA, Islam MS, Hasan M (2016). "Impact of Climate Change on Livestock in Bangladesh: A Review of What We Know and What We Need to Know" (PDF). American

Journal of Agricultural Science Engineering and Technology. 3 (2): 18–25. doi:10.54536/ajaset.v3i2.40. S2CID 248796073 – via e-palli.

20. Hennessy K, et al. (2007). "Chapter 11: Australia and New Zealand: Executive summary". In Parry ML, et al. (eds.). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Archived from the original on 8 August 2018.
21. "Climate change threatens future of farming in Europe — European Environment Agency". www.eea.europa.eu.
22. Jones P, Thornton P (April 2003). "The potential impacts of climate change on maize production in Africa and Latin America in 2055". Global Environmental Change. 13 (1): 51–59. doi:10.1016/S0959-3780(02)00090-0.
23. Baethgen WE (1997). "Vulnerability of the agricultural sector of Latin America to climate change" (PDF). Climate Research. 9: 1–7. Bibcode:1997ClRes...9....1B. doi:10.3354/cr009001.
24. Mendelsohn R, Dinar A (1 August 1999). "Climate Change, Agriculture, and Developing Countries: Does Adaptation Matter?". The World Bank Research Observer. 14 (2): 277–293. doi:10.1093/wbro/14.2.277.
25. "What's Really Driving Immigrants North from Central America". The State of Things (Podcast). 22 February 2018. Retrieved 1 June 2018.