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Climate – Smart Agriculture: A Pathway to Sustainable Resilience

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Abstract

The globe is currently experiencing the effects of the climate change catastrophe, which poses a threat to the planet. The primary negative impact of climate change is thought to be global warming, combined with other anomalies including diminished food security, lack of access to water supplies, melting glaciers, rising sea levels, and a decline in biodiversity. Climate anomalies have been linked throughout time to declining agricultural output and declining water quality. Climate has a significant impact on crop productivity. All of these factors crop growth, harvest timing, food security, and agricultural livelihoods have the potential to upset the delicate balance of agricultural ecosystems. By 2050, crop yields may drop by 30% as a result of climate change. The agricultural sector and climate change are mutually dependent. Agriculture neither causes nor contributes significantly to greenhouse gas emissions, despite being a victim of climate change. As a result, sustainable adaptation aims to reduce the environmental impact of agriculture while simultaneously modifying agricultural techniques to suit shifting climatic conditions. Climate-resilient agriculture strengthens farming systems to withstand the effects of climate change, putting an emphasis on sustainability and enhancing livelihoods, productivity, and food security. To resist droughts and extreme weather, "Conservation Agriculture" (CA) incorporates various crop rotations, decreased tillage, and soil cover. This improves soil health, water retention, and nutrient availability. One strategy that aids in directing efforts to change agri-food systems towards environmentally friendly and climate-resilient practices is called "climate-smart agriculture." Reaching globally agreed goals like the SDGs and the Paris Agreement is supported by it. Three primary goals are intended to be addressed as raising

incomes and productivity in agriculture Resilience-building and climate change adaptation cutting back on or eliminating greenhouse gas emission. For this reason, the global agrifood system needs to perform in several areas. It needs to substantially cut its greenhouse gas emissions, feed the globe, and adapt to climate change. Climate-smart agriculture (CSA) has evolved as a comprehensive solution to solve climate change concerns, end food security, and promote sustainable development in response to these difficulties.

Introduction

The main factors affecting Indian agriculture's performance are becoming more and more apparent due to climate change and its variability. Extended alterations in meteorological trends lead to a changing climate, endangering agricultural output due to extremes in temperature, more erratic rainfall, and increasing sea levels that might potentially degrade freshwater reserves along the coast and heighten the danger of flooding. The temperature increased between 1901 and 2018 by about 0.7 °C. The average Sea Surface Temperature (SST) in the Indian Ocean rose by 1 °C (or 0.7 °C globally) between 1951 and 2015. There is variations in Rainfall about 6% decrease in rainfall between 1951 and 2015, with the Western Ghats and the Indo-Gangetic Plains seeing the most of this loss. Droughts have increased in areas like Central India, the South West Coast, the Southern Peninsula, and the North-east. The main factors affecting Indian agriculture's performance are becoming more and more unpredictable climate change. Extended alterations in meteorological trends lead to a changing climate, endangering agricultural output due to extremes in temperature, more fluctuating rainfall, and rising sea levels that could potentially degrade freshwater reserves along the coast and heighten the danger of flooding. Smart agriculture for the climate Climate-smart agriculture (CCAFS and FAO 2014) is an integrated strategy that takes a comprehensive view of agriculture, encompassing crop and animal production, forest management, and fisheries for food, fuel, building materials, fibre, fodder, medicinal goods, and water (FAO 2010). One FAO's definition of CSA is the most widely used, and it reads as follows: "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of

national food security and development goals."

Three pillars of CSA

Productivity: The goal of the CSA is to raise agricultural earnings from fish, cattle, and crops in a sustainable manner while avoiding adverse environmental effects. Consequently, there will be more food and nutritional security. Sustainable intensification is a crucial idea in increasing production.

Adaptation: CSA seeks to enhance farmers' resilience by increasing their ability to adapt and thrive in the face of shocks and longer-term challenges, while simultaneously lowering their vulnerability to short-term hazards. The services that ecosystems offer to farmers and other users are given special consideration.

Mitigation: CSA should support efforts to cut down on or eliminate greenhouse gas (GHG) emissions wherever and wherever feasible. For every calorie or kilogramme of food, fibre, and fuel that we generate, it is implied that we reduce emissions. Additionally, we should look after

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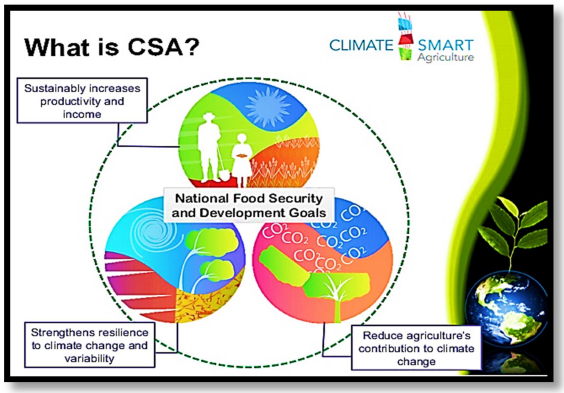
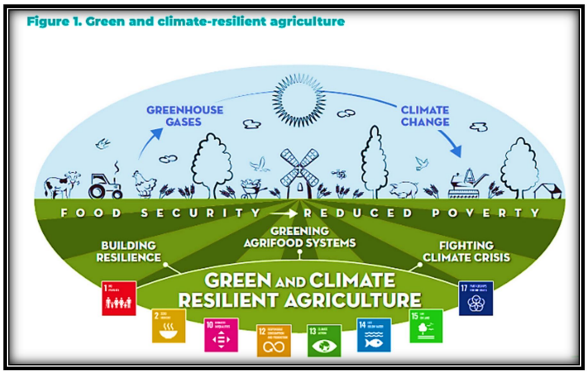
trees and soils to the fullest extent possible so that they can absorb CO2 from the atmosphere and function as carbon sinks.





Climate Change's Effect on Agriculture in India :

An investigation of the effects of climate change on agriculture and farmers was conducted by the Indian Council of Agricultural Research (ICAR) network initiative, National Innovations on Climate Resilient Agriculture (NICRA). Research shows that, in the absence of adaptation strategies, climate change forecasts for the years 2020–2039 imply that yields of irrigated rice would likely decrease by 3%, rainfed rice yields by 7–28%, wheat yields by 3.2–5.3%, maize yields by 9–10%, and soybean yields by 2.5–5.5%.

Horticulture: It is also anticipated that the production zones for apples and other temperate crops may change. Onion and tomato farming is greatly impacted by flooding.

Livestock: It is estimated that India's cattle and buffalo suffer 1.8–2 million tonnes of milk loss annually as a result of heat stress. Effect of infectious illness onset and recurrence on animal health, especially when caused by vectors, parasites, and protozoa.

Fisheries: The IPCC predicts that a rise in sea surface temperature (SST) would result in a decrease in plankton densities. Higher sea surface temperatures (SSTs) may result in lower plankton densities in coastal waters, which may have an adverse effect on the general population of fish larvae and adult fish, according to the IPCC. A rise in river water temperature has made

fish species that were previously restricted to the middle section of the Ganga accessible in the cooler river around Haridwar.

Components of Climate Resilient Agriculture

Agroforestry: Growing trees alongside crops can improve soil health, lessen soil erosion, and increase biodiversity. Farmers gain from this practice in a number of ways and it helps to retain more soil moisture.

Soil and Water Conservation: In order to enhance soil moisture retention, decrease soil erosion, and boost groundwater recharge, practices like contour bunding, farm ponds, and check dams can be used. In addition, these methods can assist farmers in addressing the increasing frequency of droughts and water scarcity brought on by climate change.

Sustainable Agriculture: Techniques like integrated pest management, crop diversification, and organic farming help to lower the need for chemical inputs and enhance soil health. In addition to improving farmers' income and food security, these practices lower greenhouse gas emissions.

Livestock Management: Livestock management strategies such as stall-feeding and mixed crops can increase the productivity and resilience of livestock systems. These approaches help lessen the burden on natural resources such as grazing areas, which are increasingly limited owing to climate change.

Challenges in adoption of Climate Resilient Agriculture

Interventions become complicated because they must operate at different scales.

Challenges with human resources and policy arise from the need for diverse stakeholders to collaborate with teams that have different experiences and approaches.

Poor extension services (research-farmer links) that result in information and training gaps, skill gaps, and widespread illiteracy among farmers are the causes of skill difficulties. Prolonged reliance on precipitation, insufficient seed supply, dispersed land ownership, and insufficient post-harvest facilities are examples of structural problems.

Concerns with policy: Measures such as the Minimum Support Price (MSP) and the subsidisation of fertilisers cause monocultures, excessive water extraction, loss of soil fertility, and extinction of natural pollinators. A lack of seeds, fragmented land holdings, an excessive reliance on rainfall, and poor post-harvest infrastructure are examples of structural problems.

Way forward in Climate Resilience Agriculture

National Action Plan on Climate Change (NAPCC), which is being implemented by the government. Among the NAPCC's missions to strengthen Indian agriculture's resilience is the **National Mission for Sustainable Agriculture (NMSA**).

Rainfed Area Development (RAD), On Farm Water Management (OFWM), and Soil Health Management (SHM) are the three main components of the NMSA that were authorised.

The Soil Health Card (SHC), the Paramparagat Krishi Vikas Yojana (PKVY), the Mission Organic Value Chain Development in North Eastern Region (MOVCDNER), and the Per Drop More Crop programme were the four additional initiatives that followed.

The National Innovations in Climate Resilient Agriculture (NICRA) flagship network initiative was introduced by the Indian Council of Agricultural Research (ICAR) in 2011 with the goal of advancing climate resilient agricultural methods. It is a multi-location, multi-sector programme with the primary goal of tackling climate change and variability while also attending to the demands of many stakeholders throughout the nation.

ICAR has made significant progress in climate resilient agriculture, as seen by the creation of

1888 climate sensitive crop varieties and the creation of **District Agriculture Contingency Plans (DACPs)** for 650 districts, among other accomplishments.

To safeguard farmers, especially small landowners, from climatic risks, the government launched the flagship yield-based **Pradhan Mantri Fasal Bima Yojana (PMFBY)** in Kharif 2016. Additionally, the **Restructured Weather Based Crop Insurance Scheme (RWBCIS)** was also implemented. The programme seeks to stabilise income for farmers who experience crop loss or damage as a result of unanticipated natural disasters or unfavourable weather patterns in order to promote sustainable production in the agriculture sector.

Conclusion

This article summaries the issue as the globe faces the difficulties of climate change, agriculture must adapt to secure food security, livelihoods, and environmental sustainability. Farmers that use climate-resilient techniques can minimise their sensitivity to climate-related shocks, increase production and revenue, and contribute to a more sustainable food system. Governments, international organisations, and civil society must assist farmers in this transition by providing the necessary resources, expertise, and policy frameworks to expand sustainable climate resilient agriculture. Together, we can create a more resilient, egalitarian, and sustainable food system for all, capable of meeting the challenges of climate change. For the purpose of preserving the environment, enhancing livelihoods, and guaranteeing food security, sustainable climate resilient agriculture is essential. Climate-resilient farming methods can boost ecosystem services, lower greenhouse gas emissions, and increase agricultural production. Scaling up sustainable climate resilient agriculture requires creative funding methods, efficient policy frameworks, and capacity building. Create a worldwide fund for climate-resilient, sustainable agriculture. Initiate a global programme for agricultural training and education that is climate resilient. Create measurements and monitoring systems for agriculture that are climate resilient.

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