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Building Resilience in Agriculture: Climate Adaptation and Mitigation Strategies

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Introduction

A wide range of risks and uncertainties, including biophysical, abiotic, climatic, environmental, biotic (diseases and pests) and economic ones, are inherent to agricultural activities. Climate change will have an impact on most of these threats in terms of intensity, extent, or frequency. The climate is a factor in many of these risks. Small farmers and marginal areas are more vulnerable to new risks as a result of increased variability brought on by many components of climate change. Extreme natural events, which lead to disasters, changes in rainfall and consequent variations in water availability, increased temperatures and seasonal shifts, and alterations in the composition of atmospheric gases are all consequences of climate change.

With medium-term (2010–2039) climate change, significant negative effects have been predicted, such as a yield drop of 4.5–9.0%, depending on the amount and distribution of temperature. A 4.5 to 9.0% negative impact on production implies that the annual cost of climate change is equal to 1.5% of GDP, given that agriculture accounts for 15% of India's GDP. Therefore, increasing agricultural output is essential to guaranteeing food and nutrition security for everyone, especially the small and marginal farmers who are most impacted and have limited assets. The long-term effects of climate change may have a significant negative impact on the poor's ability to secure a living if planned adaptation is not implemented. (NICRA, 2020).

Meaning and Definition

The term "resilience" refers to a system's and its constituent parts' capacity to foresee, absorb, accommodate, or recover from the effects of a hazardous event in a timely and effective way, including by making sure that its fundamental structures and functions are preserved, restored, or improved (IPCC, 2012).

Climate resilience in agriculture refers to the application of adaptation, mitigation, and other strategies that improve the system's ability to withstand harm and bounce back swiftly from a variety of climate-related disruptions.

Resilience: The term "resilience" has multiple definitions in the fields of development and humanitarian work. Consequently, the climate-smart agriculture compendium presents these definitions, which generally have three things in common: (FAO, 2014).

- the ability to recover from a shock
- the ability to change with the environment and
- the potential for transformation in a supportive institutional setting

Resilience, in the particular context of climate change, refers to the ability of social, economic, and environmental systems to respond to a disruptive event, trend, or disturbance by adapting, learning, and changing in ways that preserve their fundamental identity, structure, and function (IPCC, 2014).

The Necessity for Climate Resilience Practices

People's lives are being significantly impacted by climate-related risks, particularly those of the impoverished. Unpredictability is causing extreme heavy rainfall or almost no rain at all on one side, temperature rise and variations, abrupt hailstorms, and an increase in the frequency of droughts, floods, and storms. The effects of these weather patterns are particularly felt in underdeveloped nations where there is less security over food and water and a loss of livelihoods. It gets really difficult to survive in this circumstance.

Encouraging climate resilient agriculture in regions that are highly impacted by climate change is essential to ensuring food security and providing rural communities with a living wage.

Climate change is predicted to make disaster risk much more severe in the ensuing decades. Long-lasting droughts, coupled with increasingly frequent and powerful storms and floods, might weaken the ability of communities to cope with, anticipate, and recover from a series of dangerous events. In light of all of this, it would appear that it is urgently necessary to give farmers and other agriculturalists the tools they need to implement climate change-resilient agricultural practices.

Adaptation and Mitigation Strategies

Adjustments in ecological, social, or economic systems in reaction to real or anticipated stimuli and their implications are referred to as adaptations. This term describes modifications to procedures, policies, and organisational frameworks intended to reduce possible harm or take advantage of opportunities brought about by climate change (IPCC,2001).

A mitigation strategy aims to decrease the sources of emissions or increase the sinks of greenhouse gases (IPCC, 2001).

Adaptation	**Mitigation**
It addresses the impact of the climate change	It addresses the causes of the climate change
Reducing the vulnerability of natural and human systems is the goal of adaptation measures, which address the effects of climate change	Reducing the amount of greenhouse gases in the atmosphere is one way that mitigation tackles the causes of climate change

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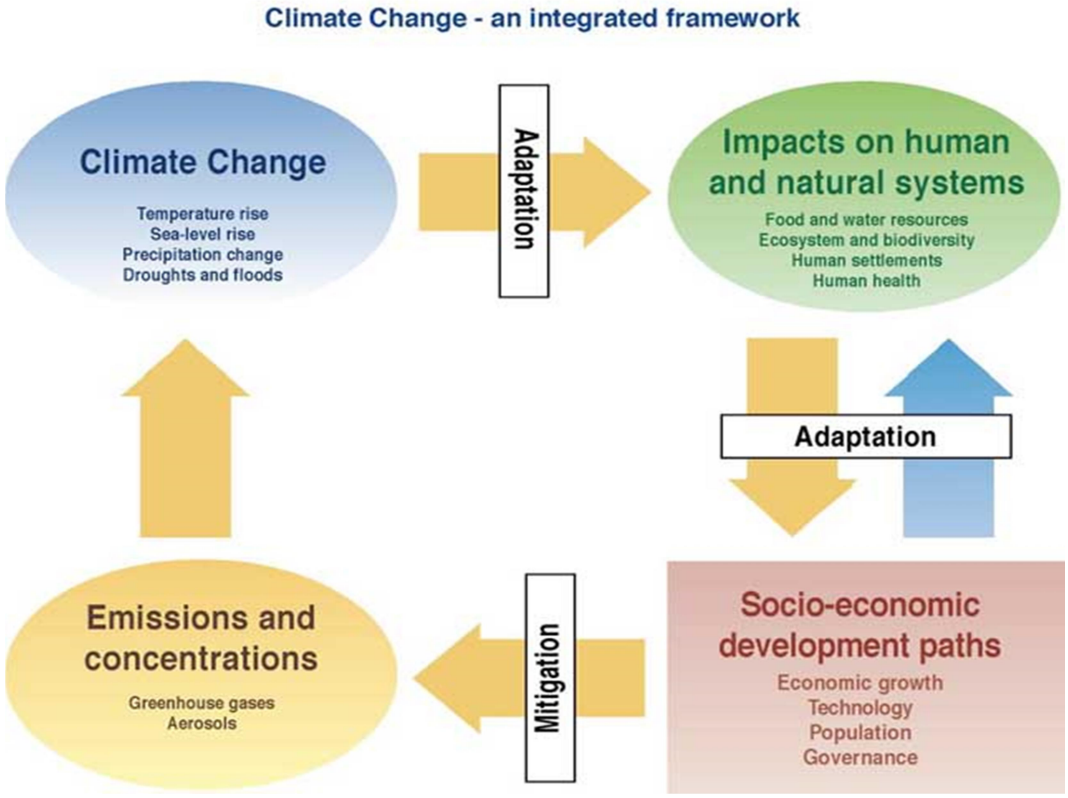

In the context of climate change, the ability to "adjust to the actual or expected climate and its effects" is known as adaptation, whereas the ability to anticipate, respond to, and recover from the effects of dangerous weather events is known as resilience to climate change.

Mitigation strategies in Agriculture

Three main strategies available for the agricultural sector to lessen the effects of climate change includes,

- Reducing emissions
- Avoiding or displacing emissions
- Removing emissions

Reducing emissions of Greenhouse gases

1. **Employing better farmland management techniques**
    - Limited disturbance of the soil (zero and minimal tillage)

- Better grazing practices, like as rotational grazing and stocking rate management, can lower emissions caused by the volatilization of organic soil carbon
- Leaching and volatile losses can be decreased by integrated nutrient management, which lowers emissions
- Increasing the effectiveness of nitrogen utilization through precision farming
- Optimising the timing of fertilizer application
- Restoring salinized and eroding soils
- Conversion of marginal agricultural soils to forests or pastures

2. **Enhancing animal nutrition methods to lower emissions caused by enteric fermentation**
    - Adding additives to food to improve the digestive system's efficiency
    - Increases in the amount and quality of pasture
    - Sowing legumes or grasses for fodder that have deeper roots and greater productivity
3. **Minimising the destruction and loss of forests**
    - Reducing deforestation and forest degradation (REDD) and adopting sustainable management of existing forests can reduce emissions
4. **Enhancing aquaculture management practices**
    - The process of choosing appropriate aquatic species populations
    - Boosting the effectiveness of feeding
    - Emissions can be decreased by switching to omnivore or herbivorous aquaculture species from the utilisation of input

Avoiding or displacing emissions

1. **Enhancing procedures after harvest**
    - Reducing food losses after harvesting through better post-harvest handling and storage can help cut emissions
2. **Increasing agricultural production's consumption of energy**

- Enhancing energy efficiency and switching to biofuels from fossil fuels will lower emissions for each food produced unit

Removing emissions

1. **Enhanced agricultural techniques**
   - Minimal tillage, or very little farming
   - Employing cover crops
   - Including agricultural residues
   - High-carbon crops: vines, tea, coffee, fruit or nut orchards
2. **Enhanced management of water and soil**
   - Crop rotation, mixed cropping, contour farming, strip cropping, growing cover crops, mulching, bunding, terracing, windbreaks and shelterbelts, organic manure, etc.
   - Reducing irrigation water distribution losses by drip and sprinkler irrigation and the use of plastic films to line canals
3. **Carbon storage is increased by agro-forestry, afforestation/reforestation, and forest restoration**
   - Combining trees and crops to provide fuel and timber
   - Establishing woody species systems in buffer strips, riparian zones, and shelter belts
   - Transformation in land use from non-forest to forest and from degraded to completely carbon-stocked forests.

4. **Mangrove planting in coastal regions**

- Mangrove replanting along the shore will produce carbon sinks

Conclusion

India is an agrarian nation with an agriculturally oriented economy. The agriculture industry is greatly impacted by climate change. It is imperative that transition to climate resilient agriculture to adapt to the changing climate. Climate-resilient agriculture (CRA) is an approach that incorporates the sustainable use of current natural resources through crop and livestock production systems in order to achieve long-term and higher productivity along with farm

incomes under climate variations. Climate resilience is a fundamental concept of managing the risks of climate change. It is important that farmers and other agriculturalists receive training that will enable them to implement climate change-resilient agricultural methods. Government and non-government organisations ought to be involved in and support the national adoption of climate-resilient agricultural (CRA) techniques.

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