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Climate resilient agricultural practices to combat climate change

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Introduction

One of the extreme environmental problems faced by people around the world in the 21st century is climate change. Climate change is defined as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCCC, 1994). Elevated levels of carbon dioxide (CO_2), increasing temperatures, and altered patterns of extreme events play significant roles in influencing the environment. Examples of such climatic extremes include droughts, heavy rainfall, floods, heatwaves, cold snaps, frost, hailstorms, and cyclones. These weather anomalies are anticipated to not only affect the area dedicated to crop cultivation but also the overall production and efficiency of agriculture. The consequences extend to water resources, agricultural yields, grazing lands, and the well-being of livestock.

Impact of climate change on agriculture and allied sector

Climate change's influence on agriculture appears as a crucial variable in influencing future food security. Agriculture, which is particularly sensitive to climate change, not only suffers the burden of climate change but also plays a critical role in driving these climatic changes. Navigating the problems of changing weather patterns and modifying management strategies to maximize harvests are key barriers to the agricultural sector's overall growth. The uncertainty in agriculture's climate sensitivity is exacerbated by regional differences in rainfall, temperature, crop kinds, cropping methods, soils, and management strategies.

Temperature and precipitation fluctuations from year to year exceed the expected changes in these meteorological parameters. Crop losses may be exacerbated by the probable increase of climatic variability caused by expected climate change. The complex impact of global warming differs per crop, further complicating the situation. The tropics, which are home to 75% of the world's population, with two-thirds relying on agriculture as their major source of income, have particular problems.

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Tropical agriculture is fragile due to factors such as low levels of technology, a broad array of pests, illnesses, and weeds, land degradation, unequal land distribution, and rapid population expansion. According to the USDA, six major crops—rice, wheat, maize, sorghum, soybean, and barley—cultivated on 40% of the worldwide cropped land produce 55% of non-meat calories and more than 70% of animal feed.

Steps to be taken for averting losses due to climate change in Agriculture and allied sectors include the following:

Adopting to latest technologies: Use weather forecasting tools to plan planting and harvesting times. Employ sensor-based technologies for monitoring soil moisture and nutrient levels. An early warning system should be put in place to monitor changes in pest and disease outbreaks. The overall pest control strategy should be based on integrated pest management because it takes care of multiple pests in a given climatic scenario. Increasing use of climate forecasting can reduce production risk.

Climate-Resilient Crop Varieties: Participatory and formal plant breeding to develop climate-resilient crop varieties that can tolerate higher temperatures, drought and salinity. Select and cultivate crop varieties that are adapted to local climate conditions. Explore genetically modified (GM) or genetically edited crops with traits such as drought resistance. Alteration in inputs, varieties and species for increased resistance to heat shock and drought, flooding and salinization is advisable. Developing short-duration crop varieties that can mature before the peak heat phase sets in.

Diversification of Crops: Plant a diverse range of crops to reduce the risk associated with climate-related uncertainties. Crop diversity helps mitigate the impact of specific weather conditions on a single crop. Diversifying income through the integration of activities such as livestock raising, fish production in rice paddies etc.

Water Management: Implement efficient irrigation practices to conserve water. Invest in water harvesting techniques such as rainwater harvesting and storage systems. Utilize drought-tolerant crops and water-efficient irrigation methods. The strategies for mitigating methane emission from rice cultivation can be sustained by altering water management, particularly promoting mid-season aeration by short-term drainage.

Soil Health Improvement: Practice conservation tillage and cover cropping to enhance soil structure and water retention. Use organic amendments to improve soil fertility and resilience. Adopt agroforestry practices to promote biodiversity and improve soil health. improving organic matter management by

promoting aerobic degradation through composting or incorporating it into soil during off-season drained period. The most efficient management practice to reduce nitrous oxide emission is site-specific, efficient nutrient management. The emission can also be reduced by nitrification inhibitors such as Nitra pyrin and dicyandiamide (DCD). There are some plant-derived organics such as neem oil, neem cake and Karanja seed extract which can also act as nitrification inhibitors.

Livestock Management Strategies: Adapt livestock breeds that are better suited to local climate conditions. Implement climate-smart practices for animal husbandry, considering temperature extremes and changing forage availability. Methane emission from ruminants can be reduced by altering the feed composition, either to reduce the percentage which is converted into methane or to improve the milk and meat yield.

Agroecological Practices: Embrace agroecological principles that integrate ecological concepts into agricultural systems. Foster biodiversity through the creation of buffer zones and wildlife corridors. Adopt resource conservation technologies such as no-tillage, laser land leveling, direct seeding of rice and crop diversification which will help in reducing in the global warming potential. Crop diversification can be done by growing non-paddy crops in rain fed uplands to perform better under prolonged soil moisture stress in Kharif. Farmers can adapt to climate changes to some degree by shifting planting dates, choosing varieties with different growth duration, or changing crop rotations.

Connecting stakeholders and policy support: Establish farmer networks for knowledge exchange on climate-resilient practices. Encourage community-based climate adaptation initiatives. Assist farmers in coping with current climatic risks by providing value-added weather services to farmers. Propose policies that encourage climate-resilient agriculture. Take advantage of government programmes and incentives to promote sustainable and resilient farming methods.

Risk management: Invest in crop insurance and risk management strategies. Diversify income sources through agro-tourism, on-farm workshops, or value-added products. Provide greater coverage of weather linked agriculture-insurance.

Training and capacity building of farmers: Provide training programs for farmers on climate-smart agriculture. Enhance farmers capacity to adapt to changing conditions through education and skill development.

Carbon sequestration: Mitigation of CO_2 emission from agriculture can be

achieved by increasing carbon sequestration in soil through manipulation of soil moisture and temperature, setting aside surplus agricultural land, and restoration of soil carbon on degraded lands. Soil management practices such as reduced tillage, manuring, residue incorporation, improving soil biodiversity, micro aggregation, and mulching can play vital roles in sequestering carbon in soil.

Implementing a combination of these measures, adapted to each region's individual context and problems, can help to enhance agricultural resilience and provide food security amid the face of climate change. Collaboration among farmers, researchers, policymakers, and communities is critical to the success of these efforts.