



CLIMATE-RESILIENT AGRONOMIC PRACTICES FOR SUSTAINABLE CROP PRODUCTION UNDER CHANGING CLIMATE CONDITIONS



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INTRODUCTION

Agriculture remains highly dependent on climatic conditions and is therefore one of the most vulnerable sectors to climate change. Global warming, changing precipitation patterns, and increased frequency of extreme weather events are adversely affecting crop productivity, soil fertility, and water availability. According to the Intergovernmental Panel on Climate Change (IPCC, 2023), climate change is expected to intensify agricultural risks in many regions, particularly in developing countries where farming systems are already constrained by limited resources. The challenge for modern agriculture is not only to increase food production for a growing population but also to ensure environmental sustainability. Climate-resilient agronomic practices have emerged as an effective strategy to enhance the adaptive capacity of agricultural systems while reducing their environmental footprint.

CLIMATE CHANGE IMPACTS ON AGRICULTURE

Climate change affects agriculture through multiple pathways:

- Increased temperature stress leading to reduced crop yields.
- Irregular rainfall causing droughts and floods.
- Increased pest and disease incidence.
- Soil degradation and nutrient depletion.
- Reduced water availability for irrigation.
- Declining productivity of major cereals such as rice, wheat, and maize.

These challenges necessitate the adoption of adaptive and sustainable agronomic interventions.

CLIMATE-RESILIENT AGRONOMIC PRACTICES

1. Conservation Agriculture

Conservation agriculture is based on

minimum soil disturbance, permanent soil cover, and crop diversification. These practices improve soil structure, reduce erosion, enhance soil organic carbon, and increase water infiltration. Long-term adoption of conservation agriculture has been shown to improve productivity while reducing production costs.

2. Crop Diversification

Crop diversification reduces production risks associated with climatic uncertainties. Inclusion of pulses, oilseeds, millets, and fodder crops enhances system resilience, improves soil fertility, and increases farm income stability. Diversified cropping systems are generally more resilient than monoculture systems under changing climatic conditions.

3. Stress-Tolerant Crop Varieties

Development and adoption of drought, heat, salinity, and flood-tolerant crop varieties provide an important adaptation mechanism. Advances in plant breeding and biotechnology have accelerated the development of climate-resilient cultivars capable of maintaining yields under adverse environmental conditions.

4. Integrated Nutrient Management

Integrated nutrient management combines organic manures, crop residues, biofertilizers, and inorganic fertilizers to maintain soil fertility and improve nutrient-use efficiency. This approach enhances soil health while reducing environmental pollution associated with excessive fertilizer use.

5. Efficient Water Management

Water scarcity is becoming a major constraint in agricultural production. Climate-resilient water management practices include drip irrigation, sprinkler irrigation, rainwater harvesting, alternate wetting and drying, and deficit irrigation. These technologies significantly improve water-use efficiency and crop productivity.

6. Precision Agriculture

Precision agriculture utilizes advanced technologies such as GPS, remote sensing, drones, sensors, and geographic information systems (GIS) to optimize resource use. Site-specific management allows farmers to apply water, fertilizers, and pesticides more efficiently, reducing costs and environmental impacts.

7. Agroforestry Systems

Agroforestry integrates trees with crops and livestock to improve ecological sustainability. Trees contribute to carbon sequestration, biodiversity conservation, microclimate regulation, and soil fertility enhancement. Agroforestry systems also provide additional sources of income to farmers.

8. Digital Agriculture and Climate-Smart Technologies

Digital agriculture uses artificial intelligence, weather forecasting tools, mobile applications, and decision-support systems to assist farmers in managing climatic risks. These technologies provide timely information regarding weather conditions, irrigation scheduling, nutrient management, and pest control.

BENEFITS OF CLIMATE-RESILIENT AGRONOMIC PRACTICES

The adoption of climate-resilient practices provides several benefits:

- Enhanced crop productivity and stability.
- Improved soil health and fertility.
- Greater water-use efficiency.
- Reduced greenhouse gas emissions.
- Increased resilience to climatic stresses.
- Enhanced food and nutritional security.
- Sustainable use of natural resources.

FUTURE PERSPECTIVES

Future agricultural development must focus on integrating modern technologies with sustainable agronomic principles. Research efforts should prioritize climate-resilient crop varieties, precision farming technologies, soil health management, and carbon sequestration strategies. Policy support, farmer training, and strengthened extension services will be critical for large-scale adoption of climate-smart agriculture.

CONCLUSION

Climate change poses unprecedented

challenges to global agriculture, threatening food security and environmental sustainability. Climate-resilient agronomic practices provide practical and scientifically validated solutions for adapting agricultural systems to changing climatic conditions. Conservation agriculture, crop diversification, integrated nutrient and water management, precision farming, agroforestry, and digital agriculture collectively enhance resilience, productivity, and sustainability. Their widespread adoption will be essential for ensuring long-term agricultural development and food security in a changing climate.

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