

# Climate Smart Agronomy: Strategies to Sustain Crop Production under Changing Climate

**Kamal<sup>1\*</sup> and Monika<sup>1</sup>**

<sup>1</sup>Department of Agronomy, CCS Haryana Agricultural University, Hisar-125004, Haryana, India

**Corresponding Author**

Kamal

Email: kamalkhroad@gmail.com



**OPEN ACCESS**

**Keywords**

Climate change, Crop productivity, Climate resilience, Sustainable agriculture

*How to cite this article:*

Kamal. and Monika. 2026. Climate Smart Agronomy: Strategies to Sustain Crop Production under Changing Climate. *Vigyan Varta* 7 (03): 100-103.

## ABSTRACT

Climate change has become a major challenge for global agriculture, significantly affecting crop productivity, resource use efficiency, and the sustainability of farming systems. Rising temperatures, irregular rainfall patterns, and frequent extreme weather events increase the vulnerability of agricultural production, particularly in regions dependent on monsoon rainfall. Climate smart agronomy has emerged as an effective approach to address these challenges by integrating adaptive and sustainable agronomic practices. It focuses on improving crop productivity, enhancing resilience to climate variability, and promoting efficient use of natural resources. Key strategies include adjustment of sowing time, adoption of climate-resilient crop varieties, efficient water management, soil health improvement, crop diversification, and integrated nutrient management. These practices help reduce production risks, improve resource use efficiency, and maintain yield stability under changing climatic conditions. Adoption of climate smart agronomic practices can therefore play a crucial role in ensuring sustainable agriculture, environmental protection, and long-term food security under changing climate scenarios.

## INTRODUCTION

**A**griculture is one of the most climate-sensitive sectors, and climate change has emerged as a major threat to

sustainable crop production across the globe. Rising temperatures, erratic rainfall, frequent droughts, floods, and heat waves are adversely

affecting crop growth, yield stability, and farmers' livelihoods. In India, where a large proportion of agriculture depends on monsoon rainfall, climate variability poses serious challenges to food security (Girma and Petros, 2024; Kirina *et al.*, 2022).

To address these issues, Climate Smart Agronomy (CSA) has gained global attention as an effective approach to sustain crop production while enhancing resilience to climate change. Climate smart agronomy focuses on adopting suitable agronomic practices that help crops adapt to changing climatic conditions, reduce production risks, and ensure long-term sustainability (Kabato *et al.*, 2025).

#### WHAT IS CLIMATE SMART AGRONOMY?

Climate smart agronomy refers to a set of agronomic practices and management strategies that aim to:

- Sustain and increase crop productivity
- Enhance resilience and adaptability to climate change
- Reduce the negative environmental impact of agriculture

In simple terms, climate smart agronomy means “producing more with fewer resources under uncertain climatic conditions.”

#### KEY CLIMATE RELATED CHALLENGES IN AGRICULTURE

- Increasing temperature and heat stress
- Irregular rainfall and prolonged dry spells
- Frequent occurrence of extreme weather events
- Decline in soil moisture and fertility
- Increased incidence of pests and diseases

These challenges necessitate the adoption of climate resilient agronomic practices.

### IMPORTANT CLIMATE-SMART AGRONOMIC STRATEGIES

#### 1. Adjustment of Sowing Time

Timely sowing is one of the most effective and low cost climate adaptation strategies. Altering sowing dates helps crops escape heat stress, terminal drought, and frost injury.

##### Benefits:

- Avoidance of extreme weather conditions
- Better crop establishment
- Improved yield stability

#### 2. Selection of Climate Resilient Crop Varieties

Use of drought-tolerant, heat tolerant, and early-maturing varieties helps reduce yield losses under climate stress.

##### Advantages:

- Better adaptability to temperature fluctuations
- Reduced risk under delayed monsoon conditions
- Stable yields under stress environments

#### 3. Efficient Water Management

Climate-smart water management practices such as mulching, rainwater harvesting, micro-irrigation, and proper irrigation scheduling play a crucial role in conserving water.

##### Key practices:

- Mulching to reduce evaporation losses
- Drip and sprinkler irrigation
- Irrigation at critical growth stages

#### 4. Soil Health Management

Healthy soils are more resilient to climate extremes. Improving soil organic matter enhances water-holding capacity and nutrient availability.

##### Practices include:

- Application of organic manures and compost
- Integrated nutrient management
- Crop residue retention

#### 5. Crop Diversification and Intercropping

Diversification of cropping systems reduces the risk of total crop failure and improves farm income under uncertain climate conditions.

##### Benefits:

- Better resource use efficiency
- Reduced pest and disease pressure
- Enhanced system resilience

#### 6. Integrated Nutrient Management

Balanced use of chemical fertilizers along with organic and biological sources improves nutrient use efficiency and reduces greenhouse gas emissions.

##### Role in climate resilience:

- Improved root growth
- Enhanced nutrient uptake
- Reduced fertilizer losses

#### 7. Weed, Pest, and Disease Management

Climate change often increases pest and disease incidence. Integrated pest and weed management practices help minimize yield losses.

##### Strategies:

- Cultural and mechanical methods
- Use of resistant varieties
- Need based chemical application

#### ROLE OF CLIMATE SMART AGRONOMY IN SUSTAINABLE AGRICULTURE

Climate smart agronomy contributes to sustainable agriculture by:

- Improving productivity under stress conditions
- Enhancing soil carbon sequestration
- Reducing input costs and environmental pollution
- Strengthening resilience of farming systems

These practices help farmers adapt to climate change while safeguarding natural resources.

#### GOVERNMENT INITIATIVES PROMOTING CLIMATE SMART PRACTICES

The Government of India is promoting climate resilient agriculture through several initiatives:

- National Mission for Sustainable Agriculture (NMSA)
- Soil Health Card Scheme
- Paramparagat Krishi Vikas Yojana (PKVY)
- National Innovations in Climate Resilient Agriculture (NICRA)

These programs support farmers in adopting climate smart technologies and practices.

#### CHALLENGES IN ADOPTION

- Limited awareness among farmers
- Resource constraints
- Lack of location-specific recommendations

- Initial investment in certain technologies

Strengthening extension services and capacity building is essential for wider adoption.

## CONCLUSION

Climate smart agronomy offers a practical, cost effective, and sustainable pathway to cope with the adverse impacts of climate change on agriculture. By adopting suitable agronomic practices such as timely sowing, efficient water and nutrient management, crop diversification, and soil health improvement, farmers can sustain crop productivity under changing climatic conditions. Widespread adoption of climate-smart agronomic strategies is essential for ensuring food security, environmental sustainability, and resilient agricultural systems in the future.

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