



Climate-Smart Agronomy: Adapting Crop Management to a Changing Climate

(*Dr. Navyashree R¹, Suchismita Dwibedi² and Dr. Gautam Veer Chauhan³)

¹Assistant professor, Department of Crop Physiology, College of Agricultural Technology, Theni – 625562

²PhD Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar-848125

³Subject Matter Specialist (Agronomy), ICAR-CRIDA, KVK Ranga Reddy, Hyderabad-501505

*Corresponding Author's email: navyashreeshakti@gmail.com

Climate-smart agronomy integrates sustainable agriculture methods with adaptation and resilience measures towards the adverse impacts of climate change. This paper talks to the challenges brought by the changing climate, which may include erratic weather conditions, global warming, and the drying up of water sources and reviews innovative crop management approaches that will be needed in order to focus on resource-saving practices and resilient crop varieties and to preserve water and soils as well as making decisions at the technology level.

Introduction

Agriculture is one of the most exposed sectors to climate change impacts such as reduced crop yields, biodiversity loss, and loss of soil fertility. Climate-Smart Agronomy develops strategies to increase agricultural resilience, provide food security, and lower greenhouse gas emissions. In this paradigm, it stresses science-based, region-specific practices by incorporating technology and policy support in sustainability.

Main Components of Climate-Smart Agronomy

Crop Diversification and Resilient Varieties

- Development and adoption of stress-tolerant crop varieties that are drought, heat, and salinity resistant.
- Promotion of crop diversification to reduce risks associated with monoculture and improve ecosystem services.
- Example: Introduction of drought-tolerant rice or salt-resistant wheat in climate-sensitive regions.

Soil Health Management

- Incorporation of organic amendments, such as compost and biochar, to enhance soil structure and water-holding capacity.
- The practice of conservation agriculture, such as minimal tillage and crop residue retention, to enhance soil health.
- Crop rotations and cover cropping to supplement nutrient management and control erosion.



Water Use Efficiency

- Precision irrigation systems, including drip and sprinkler systems, to optimize water use.
- Water harvesting and watershed management to improve water availability.
- Irrigation scheduling based on evapotranspiration rates and real-time weather forecasts.

Climate-Smart Nutrient Management

- Use of site-specific nutrient management (SSNM) and controlled-release fertilizers to reduce the loss of nutrients.
- Using organic sources of nutrients and adopting nutrient recycling practices.
- Soil fertility monitoring with sensor and mobile applications for balanced fertilization.

Agroforestry

- Integration of trees into farming systems to sequester carbon, reduce soil erosion, and improve microclimates.
- Multipurpose tree species providing shade, fodder, and fuel.
- Example: Silvopasture systems integrating crops, trees, and livestock.

Pest and Disease Management

Integrated Pest Management (IPM)

- Promoting IPM practices, which reduce dependence on chemical pesticides.
- Predictive models in pest outbreaks based on climatic data.
- Strengthening biological control and the development of pest-resistant varieties

Digital Technologies

- Using geographic information systems (GIS) and remote sensing for monitoring the effects of climate and mapping vulnerability hotspots.
- Decision-support systems using forecasts of weather and climate models for crop management.
- Utilizing smartphone applications and IoT devices to support the farmers with best practices of CSA.

Case Studies and Success Stories

Rice Intensification in India: System of Rice Intensification in India is a transformation approach to rice cultivation, which seeks productivity and sustainability. SRI focuses on wider spacing between the plants, reduced use of water, and organic manure application, which enhances healthy root development and reduces environmental damage. Practicing intermitted irrigation lessens the release of methane gases into the atmosphere, contributing to climate change mitigation. In drought-prone areas, this has proved to be useful as it increases yields for fewer resource inputs, further ensuring food security and environmental conservation.

Zero-Tillage in Wheat Production: Zero-tillage has become an emerging sustainable production technology in wheat. It has mainly picked up momentum in the Indo-Gangetic Plains, for instance. Zero-tillage helps conserve soil structure, minimize soil erosion, and conserve moisture. It also helps in conserving fuel and reducing labor cost, hence saving on farmers' pockets. It helps to timely sow wheat after the harvesting of rice, and yields increase. Zero-tillage conserves soil health and helps in reducing greenhouse gas emissions; thus, it is one of the tools in climate-smart agriculture.

Agroforestry in Sub-Saharan Africa: This has given rise to agroforestry as an essential practice in Sub-Saharan Africa: integrating trees into agricultural practices and livestock grazing to improve sustainability. The nitrogen-fixing potential of *Faidherbia albida* enhances soil fertility, contributing to an increase in crop yields while reducing dependence on chemical fertilizers. Multiple benefits include shade, fuelwood, and fodder, lessened soil erosion, and higher biodiversity. Agroforestry also enhances climate-change resilience through enhanced water holding while diversifying the incomes of producers for food and livelihoods.

Challenges of Introducing Climate-Smart Agronomy

Lack of Consciousness and Capacity Development: Far too few farmers in the developed regions have a perception of climate-smart agriculture practice.

High Upfront Investments

- This includes the cost of adopting more resource-intensive tools and technology-advancements that most small-scale farmers may find impossible to pay for
- Weak implementation of policies and incentives for CSA adoption are limiting factors.
- Data and Infrastructure Limitations
- Lack of access to real-time data and modern infrastructure can impede the effectiveness of CSA strategies.

Future Directions

Scaling up CSA requires the following:

- Public-private partnerships to be strengthened to provide financial and technical support to farmers.
- Climate-resilient infrastructure including storage facilities and irrigation systems.
- Investment in research and innovation to develop region-specific CSA practices.
- Making enabling policies in place that entice farmers into developing climate-smart agriculture, including subsidies on precision farming equipment and insurance against climate-related risks

Conclusion

Climate-smart agronomy will provide a pathway to adaptation to the impacts of climate change while ensuring sustainable crop production and food security. This approach combines modern technology, traditional knowledge, and policy support in order to provide a holistic approach to resilient agriculture. Scaling up CSA will require farmers, scientists, policymakers, and stakeholders to make coordinated efforts to create a sustainable and climate-resilient future for agriculture.

References

1. Ali, H. (2011). *Practices of Irrigation & On-farm Water Management: Volume 2*. Springer Science & Business Media.
2. Kumar, B. M., & Nair, P. K. R. (2011b). *Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges*. Springer Science & Business Media.
3. Magdoff, F., & Weil, R. R. (2004). *Soil Organic Matter in Sustainable Agriculture*. CRC Press.
4. Rakshit, A., Abhilash, P. C., Singh, H. B., & Ghosh, S. (2017). *Adaptive Soil Management : From Theory to Practices*. Springer.
5. Reddy, P. P. (2014c). *Climate Resilient Agriculture for Ensuring Food Security*. Springer.