



Extension Strategies for Climate-Smart Agriculture

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INTRODUCTION

Climate change is increasingly reshaping agriculture through erratic rainfall, rising temperatures, prolonged droughts, and frequent floods. Among all sub-sectors, horticulture — which includes fruits, vegetables, flowers, spices, and plantation crops — is especially vulnerable due to its high sensitivity to weather and water fluctuations. At the same time, horticulture offers tremendous potential for climate adaptation, income diversification, and employment generation.

Climate-Smart Agriculture (CSA) provides a framework to address these challenges by simultaneously enhancing productivity, building resilience, and reducing greenhouse-gas emissions. Yet, the real success of CSA depends not only on the technologies developed but also on how effectively these practices reach and are adopted by growers. This is where extension strategies become the critical bridge between innovation and impact.

Why Extension Matters in CSA

Extension is the backbone of agricultural transformation. In the context of CSA, it ensures that climate-relevant knowledge, tools, and techniques are translated into practical on-farm action.

1. **Bridging the knowledge gap:** Many farmers remain unaware of specific CSA practices suited to their crops and regions. Extension systems can fill this gap through tailored information and training.
2. **Managing complexity:** CSA involves integrating practices like improved varieties, efficient water and nutrient use, protected cultivation, and diversified cropping — all of which require expert guidance.
3. **Tailoring to diversity:** Crops vary widely in their management needs and market orientation. Extension must adapt recommendations to local microclimates and farming systems.
4. **Reducing risk:** Many CSA practices involve upfront investment or unfamiliar methods. Demonstrations and peer learning can build confidence and reduce adoption risk.
5. **Scaling innovation:** Extension systems link research institutions, government schemes, and farmers, ensuring that innovations are adapted and scaled effectively across regions.

Key Extension Strategies for CSA

1. Participatory Needs Assessment and Local Adaptation

Extension should begin with understanding farmers' perceptions of climate risks — such as drought, heat stress, or pest outbreaks — and their coping mechanisms. Participatory diagnostics help identify locally relevant CSA practices. Instead of promoting uniform solutions, extension must co-design interventions suited to specific crops, soil types, and socioeconomic conditions.

Grouping farmers by crop or climatic zone allows focused extension delivery. For example, fruit growers in dry regions may need training on micro-irrigation, while hill farmers may need advice on frost management and protective structures.

2. Field Demonstrations and Farmer-Field Schools

“Seeing is believing” remains one of the strongest motivators for adoption. On-farm demonstrations of CSA practices such as drip irrigation, plastic mulching, shade-net cultivation, and rain-water harvesting showcase tangible benefits.

Establishing Farmer-Field Schools (FFS) enables growers to learn through experimentation and observation. Regular interaction, problem-solving sessions, and field visits promote practical understanding and social learning. Demonstrations can also serve as training hubs for neighbouring farmers, creating local champions of climate-smart agriculture.

3. ICT-Enabled Advisory and Decision-Support Systems

Digital technologies have revolutionised agricultural extension. Mobile apps, SMS alerts, WhatsApp groups, and online platforms can deliver real-time weather forecasts, pest advisories, and crop-specific management tips.

For CSA, ICT tools can provide:

- Crop-calendar reminders for irrigation, pruning, or nutrient application.
- Alerts on temperature extremes, frost, or pest outbreaks.
- Advice on soil-moisture levels and water scheduling using sensors.

Interactive helplines, video tutorials, and digital dashboards at Krishi Vigyan Kendras (KVKs)

can further support decision-making and link farmers with experts.

4. Training, Capacity Building and Skill Development

Building farmers' capacity is fundamental to long-term CSA adoption. Extension agencies should organise focused training modules on:

- Micro-irrigation and fertigation techniques.
- Protected cultivation management.
- Climate-resilient varieties and cropping patterns.
- Integrated pest and nutrient management under changing weather.
- Soil health restoration and organic matter enhancement.

A “train-the-trainer” model can multiply outreach by empowering extension staff, input dealers, and progressive farmers to act as local facilitators. Peer learning through exchange visits and farmer-to-farmer networks reinforces adoption and innovation.

5. Linking to Inputs, Credit and Policy Incentives

CSA adoption often requires investment in equipment like drip systems, shade nets, or polyhouses. Extension personnel should guide farmers on how to access subsidies, low-interest loans, and government schemes supporting these interventions.

Collaborating with banks, cooperatives, and agribusiness firms can create integrated packages that combine financing with technical training. Extension services should also ensure farmers receive high-quality planting material, climate-tolerant varieties, and certified inputs. Creating climate-smart clusters—where infrastructure, extension, and market linkages are concentrated—can improve efficiency and encourage collective participation.

6. Monitoring, Evaluation and Feedback

Extension systems should establish mechanisms to track CSA adoption rates, yields, and resilience benefits. Data on water use, pest incidence, or yield stability during extreme weather helps quantify benefits and refine advisory messages.

Farmer feedback is equally crucial. Extension agents should regularly interact with growers to identify obstacles, assess effectiveness, and fine-tune recommendations. Sharing success stories through local media, videos, and community meetings builds motivation and social proof.

7. Multi-Stakeholder Partnerships and Scaling Up

The success of CSA extension depends on collaboration among diverse actors — research institutions, KVKs, state agriculture departments, NGOs, AgriTech companies, and Farmer Producer Organisations (FPOs).

Partnerships can integrate research findings with field realities, link weather forecasting with extension, and combine public funding with private innovation. FPOs and cooperatives are powerful vehicles for scaling up CSA practices by pooling resources, sharing infrastructure, and strengthening market access.

Tailoring Extension to Different Farming Systems

Agriculture varies greatly across regions — from rain-fed drylands to irrigated plains to hill ecosystems. Hence, extension must emphasise location-specific and crop-specific practices:

- **Crop diversification and resilient varieties:** Encourage diversification into climate-resilient crops and cultivars that can withstand temperature fluctuations, drought, or salinity.
- **Protected cultivation:** Promote polyhouses, shade nets, and low-cost tunnels to buffer climatic extremes and enable off-season production.
- **Water and nutrient efficiency:** Train growers in precise irrigation and fertigation, use of mulches, rain-water harvesting, and soil-moisture conservation.
- **Soil health management:** Encourage composting, green manuring, reduced tillage, and agroforestry to maintain soil organic matter and fertility.
- **Integrated pest management:** Provide guidance on pest monitoring, biological control, and resistant varieties to manage climate-induced pest shifts.
- **Post-harvest resilience:** Address storage, packaging, and cold-chain solutions to reduce losses caused by temperature and humidity fluctuations.
- **Risk management:** Educate farmers about crop-insurance options, diversification

strategies, and financial literacy to cope with climate shocks.

Challenges in Implementing CSA Extension

Despite progress, several constraints still limit the reach and effectiveness of CSA extension:

- **Resource limitations:** Small and marginal farmers often lack the financial means to invest in climate-smart infrastructure.
- **Fragmented production systems:** High diversity of crops makes it difficult to deliver uniform advisory services.
- **Capacity gaps among extension staff:** Many officers need updated training on CSA technologies and digital tools.
- **Technology adoption barriers:** Fear of failure, lack of confidence, and limited access to quality inputs can delay uptake.
- **Weak market linkages:** Without assured returns or price stability, farmers may hesitate to invest in new practices.
- **Inadequate data systems:** Limited monitoring of CSA outcomes restricts evidence-based planning.
- **Behavioural inertia:** Changing established cultivation habits requires consistent engagement and trust-building.

Addressing these barriers demands continuous investment in extension infrastructure, staff development, and farmer empowerment.

Recommendations for Effective CSA Extension

1. Develop region- and crop-specific CSA modules in local languages.
2. Create model farms and demonstration plots showcasing cost-effective technologies.
3. Use mobile and digital tools to provide timely weather and crop advisories.
4. Build farmer clusters and FPOs to promote collective adoption and marketing.
5. Integrate credit and subsidy information into extension programs.
6. Train extension personnel continuously in climate risk management and digital tools.
7. Encourage participatory research and farmer-led innovation.
8. Strengthen monitoring systems and share success stories widely.

9. Promote convergence between agriculture, water management, and rural development departments.
10. Align extension with value-chain development, ensuring that climate-smart production also connects to profitable markets.

CONCLUSION

The transition to climate-smart agriculture depends as much on effective extension as on technology itself. Farmers need not just

information, but confidence, skills, and institutional support to adopt new practices. By combining participatory learning, demonstration, digital outreach, and partnerships, extension systems can empower farmers to become more resilient, resource-efficient, and market-ready. Ultimately, extension strategies must aim to make climate-smart agriculture not a short-term project but a long-term transformation — ensuring that agriculture thrives sustainably in a changing climate, while securing livelihoods and food security for generations to come.