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CLIMATE-SMART HORTICULTURE FOR A NET-ZERO FUTURE

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Climate-smart horticulture (CSH) refers to the integration of sustainable practices, smart technologies, and resilient crop systems that adapt to a changing climate while reducing greenhouse gas (GHG) emissions. It aligns with the broader goal of achieving net-zero emissions, where carbon released is balanced by carbon captured or avoided. As climate change continues to pose serious challenges to global agriculture, the horticulture sector must evolve towards sustainable, resilient, and low-carbon practices. Climate-smart horticulture (CSH) emerges as a forward-thinking approach that aligns productivity with environmental responsibility. This article explores the concept of CSH and its relevance toward a net-zero future.

Climate-Smart Horticulture integrates environmentally responsible practices and modern innovations to ensure:

- Adaptation to climate variability,
- Mitigation of greenhouse gas (GHG) emissions, and
- Enhanced productivity for food, nutrition, and income security.

Unlike conventional methods, CSH is guided by a long-term vision of reducing the carbon footprint while increasing resilience against weather extremes, pests, and declining soil health.

Importance of Climate-Smart Horticulture

Horticultural crops such as fruits, vegetables, flowers, and spices are susceptible to environmental stress. Rising temperatures, erratic rainfall, and increased pest incidence have made traditional practices unreliable and resource-intensive. Therefore, adopting climate-smart practices is no longer optional, and it is essential for aiming at economic stability, sustainability and to meet carbon neutrality targets.

The Three Pillars of Climate-Smart Horticulture are,

1. Mitigation
    - Adoption of low-emission technologies: solar-powered irrigation, energy-efficient greenhouses.
    - Use of organic amendments and biofertilizers to reduce reliance on synthetic fertilizers.
    - Carbon sequestration through agroforestry and perennial horticultural systems.
2. Adaptation
    - Climate-resilient cultivars (e.g., drought-tolerant vegetables, heat-resilient fruits).
    - Mulching, drip irrigation, and protected cultivation are used to manage erratic weather patterns.
    - Pest and disease management aligned with shifting ecological conditions.
3. Productivity Enhancement
    - Precision horticulture using sensors, AI, and GIS for better resource use.
    - Integrated nutrient and water management systems to increase efficiency.
    - Diversification of crops and value-added processing to enhance farmer income.

Pathway to Net-Zero Horticulture

1. Renewable Energy Integration: Replacing diesel pumps and fossil-based heating systems with solar, wind, and biogas options reduces carbon intensity drastically.

2. Sustainable Input Management: Switching to slow-release, organic, or bio-based fertilizers and pesticides can cut N_2O emissions while improving soil health.

3. Circular Economy Approaches: Utilizing crop residues for compost, vermiculture, or biochar production closes nutrient loops and adds carbon to soil.

4. Low-Carbon Postharvest Techniques: Cold chains powered by clean energy, packaging from biodegradable materials, and efficient logistics reduce postharvest losses and emissions.

Achieving net zero in horticulture involves balancing emissions with carbon capture and avoidance:

Intervention	Benefit
Solar energy	Cuts GHG emissions from fuel-based systems
Organic inputs	Reduce soil-based emissions and improve carbon stock
Crop residue management	Minimizes methane emissions; produces bio-compost
Tree-based systems	Act as long-term carbon sinks

Urban horticulture, vertical gardens, and rooftop farming also contribute to reducing urban heat islands and improving air quality, especially relevant for youth-led initiatives in cities.

Horticulture – a Solution to Climate Change

Horticulture offers unique advantages: perennial fruit trees act as carbon sinks, vertical gardens in urban areas cool microclimates, and ornamental plants purify air. When managed with a climate-smart lens, the sector becomes not just climate-resilient but climate-positive. The strategies to mitigate climate change are as follows,

- Protected cultivation can reduce water usage by **up to 50%** and pesticide use by **70%**.
- Solar pumps reduce CO_2 emissions by **1.5–2 tons/year per pump**.
- Transitioning to organic inputs can cut nitrous oxide emissions by **30–40%**.

Conclusion

In the face of climate change, agriculture and allied sectors must evolve rapidly, and horticulture is no exception. While horticultural crops enrich diets, generate livelihoods, and add aesthetic value to our surroundings, the environmental cost of intensive practices, energy use, synthetic inputs, and high-water demand has become increasingly apparent. Therefore, transitioning to climate-smart horticulture is not merely an option, it is an urgent necessity.By blending traditional wisdom with technological innovation, it enables a contribution to a net-zero future, where food security and environmental integrity are addressed. Let the nation achieve “More Crop per Drop, More Growth with Less Carbon.”

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