

The Role of Hi-Tech Horticulture in Enhancing Agricultural Productivity and Economic Resilience in India

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Abstract

In addition to guaranteeing food and nutritional security, horticulture is essential for everyone's financial stability. With its contemporary methods that require less capital and are less reliant on external conditions, hi-tech horticulture holds promise for increasing farmer incomes and output. In light of climate change, India's agricultural productivity and economic stability depend on the adoption of high-tech horticulture. In addition to facilitating the production of fruits, vegetables, and flowers, this cutting-edge technology is essential for plant protection, conservation, and post-harvest handling, which includes value addition. This article illustrates the exciting potential of high-tech horticulture to change the agricultural environment and promote economic resilience by looking at its many elements.

Introduction

Hi-tech horticulture includes exacting production methods that enhance yield and quality in a variety of horticultural crops by optimizing input utilization at the appropriate time and quantity. Improving production and quality, it entails implementing contemporary, less capital-intensive, and environmentally dependent technologies. Farmers may achieve great production and high-quality goods with this cutting-edge, environmentally friendly method, which increases profitability.

Key Technologies in Hi-Tech Horticulture

• Aeroponics

Growing plants in an air or mist environment without the need for soil or any other aggregate media is known as aeroponics.

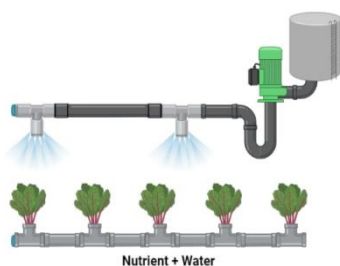


Fig 1. Aeroponics farming

Aeroponics has several benefits over conventional micro tuber production methods, such as increased multiplication rate, more tubers per unit area, improved resource usage efficiency, and more consistent tuber size.

• Hydroponics

One kind of soilless cultivation system is hydroponics. The Greek terms "hydro," which means water, and "ponos," which means work, are the origin of the name "hydroponics".

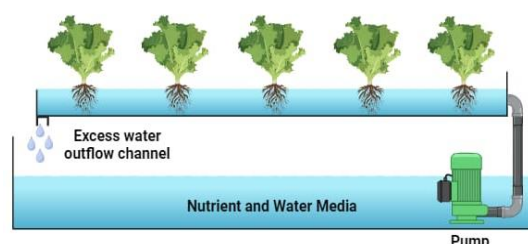


Fig 2. Cultivating *Lactuca sativa* by Hydroponics

• Aquaponics

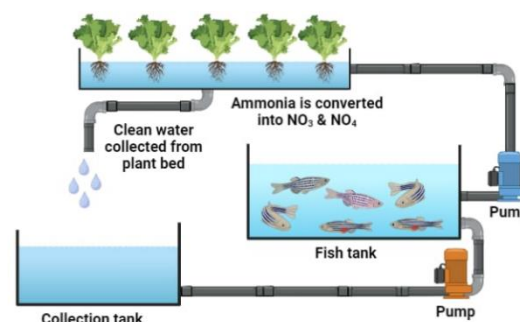


Fig 3. Efficient use of nitrogen through aquaculture

Using nutrient-rich aquaculture water as plant fertilizer, aquaponics integrates hydroponics (growing plants without soil) and aquaculture (raising aquatic creatures) into a single system. This technology offers a sustainable, economical, and chemical-free supply of nutrients for the plants by channeling aquaculture wastewater via plant beds as

opposed to releasing it into the surrounding environment. This combination addresses the unsustainable elements of running hydroponics and aquaculture separately.

• Greenhouse Technology

A very intensive agricultural method that focuses on producing high-value crops is greenhouse horticulture. Through the careful management of environmental factors like light and temperature. A very intensive agricultural method that focuses on producing high-value crops is greenhouse horticulture. Through the careful management of environmental factors like light and temperature, combined with the optimization of resource utilization and the application of advanced technologies like automation and hydroponics, this system presents prospects for higher yields, earlier harvests, more stable production, and improved product quality. In 2019, the worldwide market for greenhouse horticulture was estimated to be worth \$30 billion US, and over the following five years, it is expected to increase at an annual pace of around 9%. The adoption of new technology has been led by greenhouse horticulture, which has been influenced by globalization, the rising demand for sustainable agricultural techniques, and resource efficiency. These technologies include sensors, LED lighting, alternative fertilizer sources, and enhanced cover materials.



Fig 4. Controlled environment inside the greenhouse

• Drones in Horticulture

Drones are unscrewed aerial vehicles (UAVs) used for surveillance in a variety of businesses. Historically, businesses in industries such as mining, construction, the military, and hobbyists have used them.

But using drone technology in other horticultural fields is becoming more and more popular. Even though India is still in the early stages of adopting this technology, several businesses are working to improve agricultural productivity by making it easily available to Indian farmers.

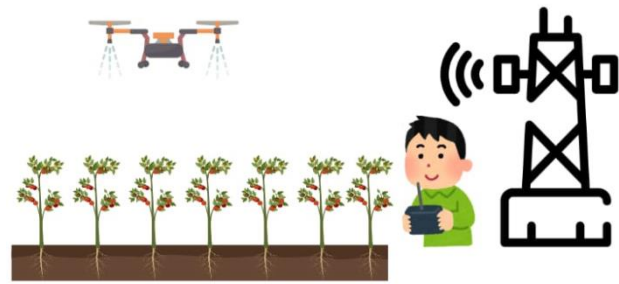


Fig 5. Collection of information by using drones

• Sensors, IoT and RS

There are several methods available to measure the N, P, and K levels in soil. They consist of electrochemical sensors based on ion-selective membranes (ISM), biosensors based on enzymes, biosensing techniques employing molecular-imprinted polymers (MIPs), electro-reduction of nitrate to ammonium ions on electrodes made of copper, sensors based on fluorescence, sensors based on tamers, on-the-go spectroscopy, and electrophoresis-based techniques.

Furthermore, optical techniques are employed, including the usage of optical fiber sensors, camera sensors, radiometric pH-dot sensors, holographic sensors, and fluorometric sensors. Magnetoelastic pH sensors, cantilever and microcantilever sensors, and conductimetric, potentiometric, and acoustic approaches are some other ways.

Tools of Hi-Tech Horticulture

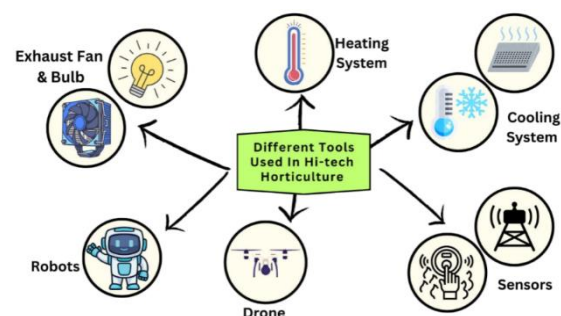


Fig 6. Tools used in Hi-tech horticulture

Conclusion

High-tech horticulture uses contemporary technology to transform agricultural techniques. Techniques like hydroponics, vertical farming, and aeroponics are examples of this. Leading this change is greenhouse horticulture, which combines digitization and automation for productive output. Drones and artificial intelligence (AI) technologies improve crop monitoring and precision farming. When coupled with genetic approaches, high-tech horticulture increases yield, quality, and stress tolerance. Both food security and climate change are

addressed by this paradigm shift toward sustainable approaches. A more promising and sustainable future for agriculture is promised by hi-tech horticulture, which is fueled by continuous technological improvements.

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