AGRICULTURAL EXTENSION JOURNAL
ISSN 2582- 564X

Available Online at www.aextj.com
Agricultural Extension Journal 2025; 9(1):40-42

SHORT COMMUNICATION

Horticulture under Smart Greenhouse

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Received: 15-12-2024; Revised: 25-01-2025; Accepted: 19-02-2025

ABSTRACT

The process of producing fruits, vegetables, flowers, and other decorative plants in a controlled, high-tech greenhouse environment that uses cutting-edge technologies to maximize growing conditions is known as horticultural crop production under smart greenhouse systems. Smart greenhouses offer a controlled environment where essential elements, such as temperature, humidity, light, and CO_2 levels are accurately maintained, in contrast to traditional techniques of horticulture crop development where variables, such as weather, soil conditions, and pests can be unpredictable. As a result, farmers may produce crops with greater consistency in quality and quantity while using fewer resources and having a smaller negative impact on the environment. The present manuscript will elaborate several vital features of horticultural crop cultivation under smart greenhouses along with different benefits.

Key words: Automation, IoT, Greenhouse, Climate, Irrigation, Pest management

INTRODUCTION

The size of the global commercial greenhouse market was estimated at USD 39.6 billion in 2023 and is projected to increase at a compound annual growth rate of 11.6% from 2023 to 2028, reaching USD 68.7 billion. Global demand for commercial greenhouse services and solutions is increased by a number of significant causes (Li *et al*., 2012). Commercial greenhouses offer the chance to extend growing seasons, mitigate the impact of unfavorable weather, and guarantee consistent agricultural yields (Gruda *et al*., 2019). Furthermore, the transparency and traceability offered by greenhouse-grown products find a considerable market resonance as consumers become more conscious of the quality and provenance of their food (CGMR, 2023).

India currently only has about 50,000 hectares under protected farming, compared to China's 2 million hectares. In the next 4–5 years, the area under protected cultivation must be increased fourfold, to over two million hectares. In addition to offering high water and nutrient use efficiency, protected cultivation can readily boost output and productivity by 3–5 times compared to open or outdoor field cultivation (Patil *et al*., 2023). Hence, the manuscript will detail horticultural crop production under a smart greenhouse system.

Vital Features

Smart irrigation system

Smart irrigation systems minimize water wastage and guarantee that crops receive the right amount of hydration for optimum growth by using sensors to supply accurate amounts of water to plantsWang *et al*. (2020). This is particularly important in areas with limited water supplies where conserving resources is a top concern (Koukounaras, 2020).

Automation in climate control

Regardless of the outside weather, smart greenhouses use automated technologies to

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control the temperature, humidity, and ventilation, guaranteeing that the crops are grown in the best possible conditions (Rayhana *et al*., 2020). This is particularly helpful for crops, such as lettuce, tomatoes, and cucumbers that need particular environmental conditions (Wang *et al*., 2020).

Artificial light

LED grow lights are used to give plants the proper light spectrum required for photosynthesis, extending growing seasons and supplementing natural light (Chen *et al*., 2020). According to the particular requirements of various crops, such as flowers, tomatoes, or herbs, smart greenhouses may modify the amount of light and how long it lasts (Wang and Luo, 2024).

Common Crops

High-tech greenhouses can be beneficial for different horticultural crops, such as herbs (mint, basil, etc.), leafy vegetables (spinach, lettuce, etc.), flowers (orchids, roses, etc.), tomatoes, and cucumbers, different ornamental and potted plants (Patil *et al*., 2023).

Improved yield and resource use efficiency

Smart greenhouses may greatly increase agricultural productivity by optimizing environmental conditions, enabling the production of premium fruits, vegetables, and flowers all year round (Maraveas *et al*., 2021). Compared to conventional farming practices, smart greenhouses are made to consume fewer resources. They are an eco-friendly answer to today's agricultural problems since they require less energy, less water, and help save nutrients (Gruda *et al*., 2019). To further improve sustainability, they also use renewable energy sources, such as solar panels.

Data collection and environment monitoring

Critical parameters including temperature, humidity, soil moisture, light intensity, and even CO_2 levels are continuously monitored by sensors positioned throughout the greenhouse (Kirci *et al*., 2022). Artificial intelligence or machine learning is used to gather and evaluate this data to provide recommendations and real-time adjustments for enhancing crop growth (Chen *et al*., 2020).

Integrated disease and pest management system

Utilizing technology, smart greenhouses are able to identify and control illnesses and pests before they become serious issues (Patil *et al*., 2023). By detecting early indicators of disease or insect infestation, smart cameras, image recognition software, and sensor networks enable focused interventions without the need for excessive pesticide use (Farooq *et al*., 2022).

CONCLUSION

A major advancement in contemporary agriculture is the production of horticultural crops in smart greenhouse systems. These systems produce the perfect atmosphere for growing high-quality crops all year round by combining cutting-edge technology, such as robotics, hydroponics, automatic watering, climate management, and artificial lighting. Smart greenhouses are a viable way to satisfy the expanding need for food and decorative plants worldwide while reducing their negative effects on the environment because of its capacity to maximize resource utilization, enhance sustainability, and boost yields.

REFERENCES

1. CGMR-Commercial Greenhouse Market Report. Report Code: AGI 4088; 2023. Available from: https://www.marketsandmarkets.com/Market-Reports/commercial-greenhouse-market-221045451.html
2. Wang J, Chen M, Zhou J, Li P. Data communication mechanism for greenhouse environment monitoring and control: An agent-based IoT system. Inf Process Agric 2020;7:444-56.
3. Farooq MS, Javid R, Riaz S, Atal Z. IoT based smart greenhouse framework and control strategies for sustainable agriculture. IEEE Access 2022;10: 99394-420.
4. Gruda N, Bisbis M, Tanny J. Impacts of protected vegetable cultivation on climate change and adaptation strategies for cleaner production-a review. J Clean Prod 2019;225:324-39.
5. Kirci P, Ozturk E, Celik Y. A novel approach for monitoring of smart greenhouse and flowerpot parameters and detection of plant growth with sensors. Agriculture 2022;12:1705.

6. Koukounaras A. Advanced greenhouse horticulture: New technologies and cultivation practices. Horticulturae 2020;7:1.
7. Li S, Wang M, Zhang M, Li M, Sigrimis N, Anastasiou A. Application of IoT Technology in Greenhouse Management. Dallas, Texas: American Society of Agricultural and Biological Engineers; 2012. p. 1.
8. Maraveas C, Loukatos D, Bartzanas T, Arvanitis KG, Uijterwaal JF. Smart and solar greenhouse covers: Recent developments and future perspectives. Front Energy Res 2021;9:783587.
9. Patil S, Munshi MM, Prashantha C. Greenhouses (protected) cultivation: Importance, scope, and status. Int J Innov Res Technol 2023;9:276-8.
10. Rayhana R, Xiao G, Liu Z. Internet of things empowered smart greenhouse farming. IEEE J Radio Freq Identification 2020;4:195-211.
11. Wang C, Luo L. Application of smart technology and equipment in horticulture. Horticulturae 2024;10:676