AI and IoT in Post-Harvest Management: A Smart Approach to Reducing Food Waste and Enhancing Sustainability

Visman Kour[1]*, Neeraj Gupta[2], Priya Uday Shinde[3] and Simran Kour [4]

[1]M. Sc Scholar, [2]Professor, [3]PhD Scholar, [4]M. Sc Scholar, Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha, Jammu-180009, J&K, India,

Corresponding Author
Visman Kour
Email: vismankour1111@gmail.com

OPEN ACCESS

Keywords

Post-harvest, Artificial Intelligence, Internet of Things, Food Loss, Shelf Life, Smart Farming

How to cite this article:

Kour, V., Gupta, N., Shinde, P. U. and Kour, S. 2025. AI and IoT in Post-Harvest Management: A Smart Approach to Reducing Food Waste and Enhancing Sustainability. *Vigyan Varta* 6(7): 78-81.

ABSTRACT

Post-harvest losses are one of the biggest global concerns, threatening food security and financial stability. The traditional approaches often do not do justice in terms of conserving perishable produce, resulting in large-scale wastage. The present article discusses the innovative capabilities of cutting-edge technology, in this case, the pairing of Artificial Intelligence (AI) with the Internet of Things (IoT), in transforming post-harvest management. Through real-time monitoring, predictive analysis, and automated action, these technologies provide unprecedented scope for extending shelf life, preventing waste, and improving the general efficiency and sustainability of food supply chains.

INTRODUCTION

Food loss and waste (FLW) is a global concern, with it being estimated that one-third of food produced for human consumption is lost or wasted each year (Al-Amin *et al*., 2021). The biggest share of these losses is realized during the post-harvest stage, especially in developing nations, through lack of proper infrastructure, poor handling procedures, and limited accessibility of advanced preservation technology (Verma *et al*., 2025). The impact is widespread, worsening food security, causing losses for farmers and stakeholders, and putting pressure on environmental resources.

The need for immediate response in coping with post-harvest complications has triggered the creation and incorporation of new technology. Among these, AI-IoT convergence is one of the most significant breakthroughs. They provide the possibility of leveraging proactive over reactive approaches through data-oriented strategies in processing post-harvest, thus improving the quality, security, and efficiency of supply chains.

1. The Promise of AI and IoT in Post-Harvest Management

The integration of AI and IoT technologies is reshaping post-harvest practices by enabling intelligent decision-making and automated control throughout the supply chain.

1.1. Real-time Monitoring and Quality Control: IoT devices, with their advanced capabilities, are able to track dozens of parameters that are important for maintaining fresh produce. They track temperature, humidity, ethylene, CO2 levels, and even volatile organic compounds that indicate spoilage (Huang *et al.*, 2023). They are installed in warehouses, transport vans, and even inside packaging itself. The information is then sent in real-time to a centralized system, and all stakeholders can gain instantaneous and accurate insight into the condition of the produce. The vast information is then processed into actionable information through AI algorithms. For example, machine learning algorithms can observe patterns of temperatures and levels of humidity to forecast the arrival of spoilage or the ripening window for particular fruits. Automated grading and sorting systems are enabled through computer vision, which is a subdivision of AI, allowing for identifying defects, diseases, and ripeness levels with unprecedented levels of accuracy, often beating human capacity (Mishra *et al.*,2024). Not only is it less costly in terms of labor, but it also provides uniformity of quality and prevents human errors during the sorting process.

1.2. Predictive Analytics for Shelf-Life Optimization: One of the most effective applications of AI in post-harvesting is predictive analytics. AI models can predict the shelf life of produce based on past information regarding crop properties, environmental factors, and patterns of spoilage, and using this information make dynamic adjustments in the conditions of the stores, routing of the transport, and timing of market arrival, increasing product freshness and avoiding early spoilage possibilities (Anusha *et al.*, 2024). For instance, in case of increased risk of fungal growth in specific produce based on relatively higher humidity levels predicted by the AI model, dehumidification processes can be automatically triggered or proactive early distribution advised. This approach immensely lowers losses otherwise faced through unexpected spoilage.

1.3. Smart Storage and Logistics: Smart warehouses with AI technology employ robotic picking, packing, and piling of produce, reducing damage and maximizing efficiency. The systems, coupled with IoT sensors, can adjust shelving formats as per product, projected shelf life, and demand. AI could also streamline transport routes, taking into account temperature control needs, traffic, while meeting deadlines, further enhancing product freshness upon arrival (Verma *et al.*, 2025).

1.4. Traceability and Blockchain Integration: The coupling of AI and IoT with blockchain technology has brought unprecedented levels of transparency and traceability in the food supply chain (Anusha *et al*., 2024). Each phase of the post-harvest process, from harvesting through to packaging and transport, can be tracked on an immutable record. This allows consumers full information concerning the origin, handling, and quality of the food consumed, as well as fast detection and containment of food safety concerns.

Case Studies and Impact

The implementation of AI and IoT in post-harvest management is yielding tangible benefits across various agricultural sectors. Table 1 illustrates some key innovative technologies and their reported impacts.

Table 1: Innovative Post-Harvest Technologies and Their Impact

Technology	Application in post-harvest	Expected Impact	Reference
IoT-Integrated Cold Chain Monitoring	Real-time monitoring of temperature and humidity during storage and transport of perishable goods.	Reduces spoilage, ensures optimal conditions, enables remote monitoring and corrective actions.	Huang *et al.* (2023)
AI-Powered Optical Sorting	Automated identification of defects, diseases, and ripeness levels in fruits and vegetables.	Increases sorting accuracy, reduces labor costs, improves product consistency, minimizes waste.	Mishra *et al.* (2024)
Active Packaging with Smart Sensors	Packaging materials that interact with the food or environment, incorporating sensors to monitor quality.	Extends shelf life, alerts to spoilage, enhances food safety, provides real-time quality data to consumers.	Yildirim *et al.* (2021)
Predictive Analytics for Ripening	AI models forecasting optimal harvest times and ripening stages based on environmental and genetic data.	Optimizes harvest efficiency, reduces premature spoilage, ensures peak quality at market.	Anusha *et al.* (2024)
Solar-Powered Cold Storage	Decentralized refrigeration units powered by photovoltaic panels in off-grid regions.	Provides sustainable cooling solutions, reduces energy costs, expands access to cold chain in rural areas.	Al-Amin *et al.* (2021)

Challenges and Future Directions

While the scope for AI and IoT in post-harvest is vast, there are a number of challenges that have to be overcome for large-scale applications. They are the huge investments required, the requirement for having strong data infrastructure and connectivity in the rural sector, and the creation of standardized data exchange and interoperability protocols for various systems. Data privacy and security concerns also need to be attentively dealt with. There is, however, hope for the future of AI and IoT in post-harvest management despite these challenges. Future research and advancement in the field of explainable AI for improved decision-making, low-cost and strong sensor development, and inclusive platforms for smooth data flow will further expedite their implementation. The integration of these technologies together with collaborative research from researchers, industrial workers and policy makers will be the key to constructing more resilient, efficient, and sustainable food systems for all.

CONCLUSION

Innovative technology, specifically the synergetic blending of Artificial Intelligence and the Internet of Things, has the potential to transform post-harvest management. Through offering unmatched capacities of real-time monitoring, predictive analysis, and automated intervention, they provide an effective weapon against food loss and food waste. Adopting these tools is more than a technological advancement but also amounts to a qualitative change towards greater sustainability and food security for farmers, consumers, and the planet as well.

REFERENCES:

Al-Amin, M., *et al*. (2021). Solar-Powered Cold Storage: A Sustainable Solution for Preserving Perishable Foods in Developing Countries. *International Journal of Advanced Biochemistry Research*, *9*(3), 89-92.

Anusha, M., Sri, K. R., Lokesh, M., Deepthi, N. M., & Malleswari, M. D. (2024). Postharvest Management Techniques for Improved Shelf Life of Horticultural Crops: A Review. *Journal of Experimental Agriculture International*, *46*(11), 362-380.

Huang, Q., & Yan, X. (2018, July). On the application of Internet of Things (IoT) in cold chain logistics management. *In 2018 International Symposium on Communication Engineering & Computer Science (CECS 2018)*. Atlantis Press. https://doi.org/10.2991/cecs-18.2018.83

Mishra, A., Kaur, S., & Mishra, R. (2024). Sorting machine for fruits and vegetables for agricultural advancements using IoT. International Journal of Research and Review in Applied Science, Humanities, and Technology, 1(2).

Verma, S., Kumar, S., Kumar, V., Yadav, S., Singh, P., Saurabh, A., Kumar, A., & Jain, M. (2025, February 8). *Recent advancements and innovations in post-harvest handling, storage, and technology for vegetables: A review*. *Archives of Current Research International, 25*(2), 161–180. https://doi.org/10.9734/acri/2025/v25i21076

Yildirim, M., *et al*. (2021). Active Packaging for Enhanced Shelf Life and Food Safety: A Review. *Food Packaging and Shelf Life*, *29*, 1007.