


# Chapter 10


## Emerging Trends in Nanotechnology, Autonomous Farms, and Collaborative Agri- Industry Marketing: The Future of AI in Food Production

**Kundan Kumar**

 <https://orcid.org/0009-0001-6831-0676>


*Assam University, Silchar, India*

**Azmirul Hoque**

 <https://orcid.org/0009-0002-7220-9818>

*Assam University, Silchar, India*

**Mrutyunjay Padhiary**

 <https://orcid.org/0000-0002-2236-568X>

*Assam University, Silchar, India*

**Pranjal Saikia**

 <https://orcid.org/0009-0008-5564-2808>

*Assam University, Silchar, India*

### **ABSTRACT**

*New approaches to agricultural production are needed in light of the growing demand for food production brought on by population growth, resource scarcity, and*

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*climate change. The solutions to these problems have been developed by combining AI, nanotechnology, and autonomous systems. Applications of AI support precision farming, yield prediction, crop monitoring, and improved food safety. Nanotechnology enhances food quality, microbial detection, and shelf-life prediction, mostly through AI-powered nano-sensors and smart packaging. Autonomous systems reduce labor dependency by enabling automated seeding, watering, and harvesting. Agricultural markets are more efficient because of AI-driven supply chain optimization, market data analysis, and traceability. However, problems like scalability, operational expenses, and data quality still exist in spite of these advancements. This chapter emphasizes the value of corporate partnerships, targeted research, and policy interventions in advancing market-based innovations, sustainable farming methods, and food safety.*

## **1. INTRODUCTION**

### **1.1 Background**

Agroecosystems are greatly impacted by mining, industrial processes, and agricultural practices, all of which call for sophisticated methods to lessen their negative environmental effects (Padhiary & Kumar, 2024a). Nanotechnology, which is the manipulation of materials at the nanoscale (1-100 nm), has given a new dimension to agricultural and food production by enhancing crop yield, food quality, and safety via targeted delivery systems, precision monitoring, and innovative food packaging. Nanoparticles deliver nutrients and agrochemicals directly to plants, reducing wastage and environmental contamination (Padhiary, Roy, et al., 2025; Singh et al., 2021). Nano-sensors detect soil conditions, nutrient deficiencies, and pests in real-time, enabling precision agriculture. Smart delivery systems optimize resource utilization. In food processing and quality control, nano-encapsulation improves the bioavailability of nutrients, vitamins, and bioactive compounds. Nano-sensors detect contaminants, ensuring food safety throughout the supply chain. Smart packaging with antimicrobial and barrier properties extends shelf life, reducing food waste (Nasution et al., 2023). Nanotechnology also offers environmental and sustainability benefits by optimizing inputs, reducing waste, and enhancing food preservation. It bridges the gap between food security and sustainability by improving agricultural productivity, food safety, and consumer trust.

Autonomous farming, a trend fueled by robotics, artificial intelligence (AI), and the Internet of Things (IoT), is changing agricultural practices by automating key tasks, reducing labor dependency, and improving operational efficiency (Padhiary, 2025). This includes precision farming, where autonomous tractors, drones, and robotic equipment perform tasks like planting, irrigation, fertilization, and harvesting

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