



IoT in Agriculture

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Received: April 01, 2024

Published: April 18, 2024

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Abstract

The introduction of Internet of Things (IoT) technology in agriculture has changed traditional farming practices and provided a data-based and efficient approach to crop management. IoT in agriculture involves interconnected devices embedded with sensors, software, and connectivity capabilities that collect and exchange data. Advanced analytics techniques are used to analyse this data, providing valuable insights for farmers to enable precision farming practices, resource optimization, disease detection, improved decision-making, and enhance productivity while reducing waste. Farmers can make well-informed decisions for improved crop management thanks to data-driven insights. This paper focuses on the challenges faced by small-scale farmers in implementing Internet of things solutions in agriculture.

Keywords: Internet of Things (IoT); Agriculture; Traditional Farming Practices; Data-Based; Efficient Approach; Crop Management; Interconnected Devices; Sensors; Software; Connectivity; Advanced Analytics Techniques; Precision Farming Practices; Resource Optimization; Disease Detection; Decision-Making; Productivity; Waste Reduction; Data-Driven Insights; Small-Scale Farmers; Challenges; Implementation; Cyber Security

Introduction

IoT technology in agriculture

The introduction of IoT technology is driving a shift in the agricultural sector in India. To improve productivity and efficiency, the country is actively applying IoT technologies in agriculture. IoT and Artificial Intelligence (AI) are used in several projects and initiatives, including the National Interdisciplinary Cyber Physical Systems Mission and the Technology Innovation Hub (TIH), to transform agricultural technologies. Applications for these technologies include computer imaging, smart greenhouses, livestock monitoring, climate monitoring, precision farming and agricultural drones. The implementation of IoT in agriculture aims to optimize agricultural activities, eliminate waste, develop climate resilience and provide timely agricultural advice to meet the growing demand for food production due to the growing population. The integration of Internet of Things technologies (IoT) in agriculture has changed traditional farming practices and provides a data-based

and efficient approach to crop management. IoT applications in agriculture enable accurate farming practices by providing real-time data on various parameters such as temperature, soil moisture, nutrient levels and crop health.

IoT in agriculture involves interconnected devices embedded with sensors, software, and connectivity capabilities that collect and exchange data. Advanced analytics techniques are used to analyse this data, providing valuable insights for farmers to enable precision farming practices, resource optimization, disease detection, improved decision-making and enhance productivity while reducing waste.

IoT market

The size of the IoT market for agriculture was estimated at USD 12.5 billion in 2022. During the projection period (2023 - 2032), the Internet of Things (IoT) in the Agriculture market business is expected to increase at a compound annual growth rate (CAGR) of

45.80%, from USD 15.178 billion in 2023 to USD 71.753 billion by 2032 [1-6]. The growing need for effective farming methods and

the expanding government backing for agricultural technologies are driving the worldwide Internet of things (IoT) in the agriculture sector.

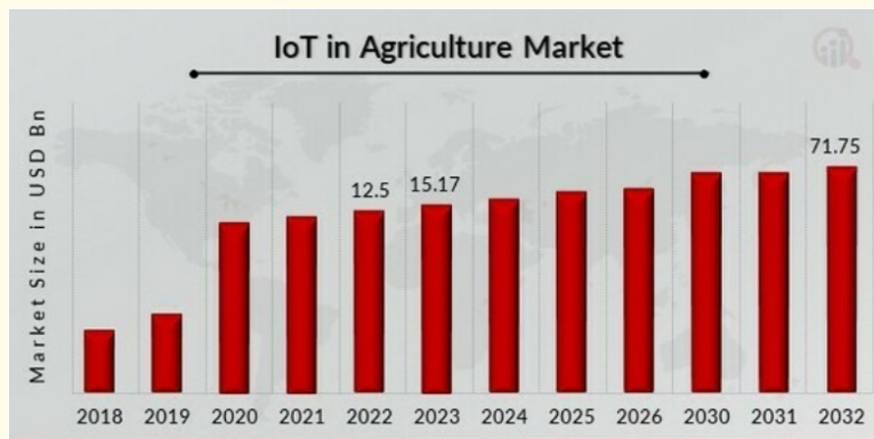


Figure 1:

Source: Secondary Research, Primary Research, MRFR Database, and Analyst Review

IoT in agriculture application insights

Aquaculture indoor farming, precision crop farming, livestock monitoring, integrated pest management, and water supply management are all included in the market segmentation of IoT in agriculture depending on application. Due to its capacity to minimise

inputs like water, fertiliser, and pesticides, precision crop farming helps farmers increase sustainability and cut costs. For this reason, it dominated the market.

IoT in agriculture market, by application, 2022 and 2032 (USD billion)

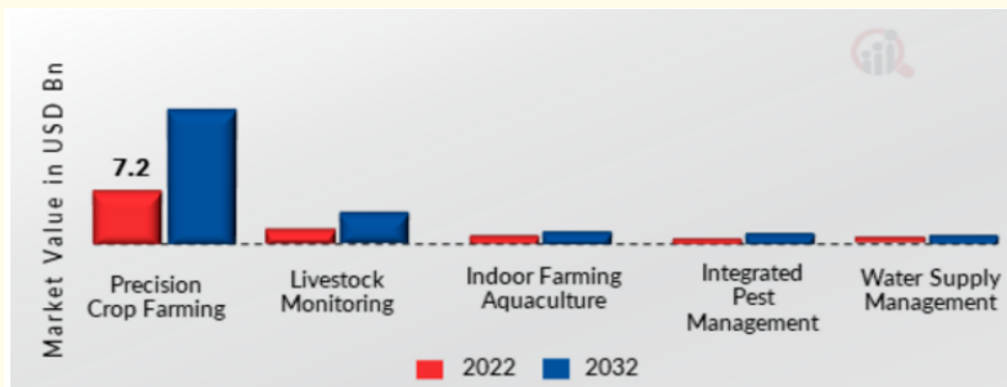


Figure 2:

Source: Secondary Research, Primary Research, MRFR Database, and Analyst Review.

Applications and benefits of IoT in agriculture

Applications of IoT in agriculture

- **Real-Time Monitoring:** Internet of Things (IoT) sensors offer real-time data on temperature, humidity, soil conditions, and growing conditions tailored to individual crops.
- **Resource Optimisation:** Farmers may manage resources more effectively and waste less water and energy by using data-driven insights.
- **Automation:** By eliminating manual labour and increasing productivity, IoT enables autonomous farming operations like precision spraying and automated irrigation systems.

- **Data Analytics:** State-of-the-art methods for extracting valuable insights from large datasets help with yield forecasts, illness identification, predictive modelling, and the best use of available resources.

Benefits of IoT in agriculture

- **Enhanced Productivity:** Higher crop yields are the result of resource optimisation brought about by IoT technology.
- **Effective Resource Management:** Accurate resource management is made easier by real-time data monitoring, which also cuts down on waste.
- **Improved Decision-Making:** Farmers can make well-informed choices for improved crop management thanks to data-driven insights.
- **Cost Reduction:** IoT-enabled automation and resource optimisation result in lower operating expenses.
- **Sustainability:** By guaranteeing effective resource usage and minimising environmental impact, IoT encourages sustainable farming methods.

Some challenges faced by small-scale farmers in implementing IoT solutions

- **Cost:** For small-scale farmers, the initial outlay of funds for sensors, devices, and communication infrastructure may be expensive.
- **Limited Connectivity:** The transmission of real-time data that is essential for the successful deployment of IoT is hampered in rural locations by the frequent absence of dependable internet connectivity.
- **Data management:** Robust data management methods and expertise are needed to handle the massive volume of data created by IoT devices.
- **Interoperability:** When IoT platforms and devices from various manufacturers may not integrate smoothly, compatibility problems may occur.
- **Cybersecurity:** As more IoT devices are used, the potential of cyber threats and data breaches rises, necessitating the implementation of strong security measures.

- **Gap in Skills:** It's possible that small-scale farmers lack the technological know-how required to install and maintain Internet of Things systems.
- **Education:** Providing adequate training and education programs is essential to ensure farmers can fully leverage the benefits of IoT in agriculture.

Security risks associated with IoT devices in Agriculture

- **Data Theft:** Sensitive customer and corporate information may be stolen from IoT devices due to potential data breaches.
- **Resource Control:** Unauthorised access to IoT devices could allow attackers to alter resources that sensors and devices oversee.
- **Equipment Damage:** Farming activities may be hampered by malicious actors' potential to destroy equipment controlled by IoT devices.
- **Disruption of Food Supply:** A cybersecurity incident in precision agriculture might have the biggest effect by upsetting the food supply chain, which would have an impact on society.
- **Reputation Loss:** If information about a data breach or hack on IoT devices is made public, farmers may suffer reputational harm. IoT devices in agriculture may be exploited to create botnets that are then utilised for DDoS attacks and other nefarious purposes. This is known as botnet hijacking.

Farmers can protect their IoT devices from cyber-attacks by following these key practices

- **Investigate Security Features:** To make sure an IoT device satisfies cybersecurity standards, investigate its security features, encryption capabilities, authentication techniques, and firmware update choices before making a purchase.
- **Modify the Default Configuration:** To lessen vulnerabilities and unauthorised access to IoT devices, change the default passwords, turn off unused functions, and restrict access points.
- **Regular Updates:** Update routers, modems, firmware, and IoT devices with the most recent security updates to fix problems and vulnerabilities that hackers might exploit.

- **Secure Network Configuration:** To safeguard data and network integrity, create a separate network just for IoT devices, employ firewalls, use robust encryption, and think about utilising a virtual private network (VPN).
- **Robust Authentication:** To enhance security and guarantee that only authorised users can access IoT devices and systems, activate two-factor authentication (2FA).
- **Monitor Activity:** Regularly review device permissions, monitor network activity for any anomalies, and stay vigilant for signs of compromise or intrusion.
- **Educate Yourself:** Stay informed about cybersecurity trends, threats, and best practices in the IoT landscape to make informed decisions and protect your IoT devices effectively.

Conclusion

In conclusion, the implementation of IoT technology in agriculture aims to optimize agricultural activities, improve productivity, optimizing resource usage, and enhancing productivity while reducing manual labour and waste and provide real-time data for accurate farming practices. The IoT market for agriculture is expected to grow significantly, driven by the need for effective farming methods and government support. However, small-scale farmers face challenges such as cost, limited connectivity, data management, interoperability, cybersecurity, skills gap, and the need for education and training. It is important for farmers to protect their IoT devices from security risks by following key practices such as investigating security features, modifying default configurations, regular updates, secure network configuration, robust authentication, monitoring activity, and staying informed about cybersecurity trends.

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