APPLICATIONS 3D PRINTING AND INNOVATIONS IN SMART AGRICULTURE

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Introduction. Emerging technologies, including 3D printing, have played an important role in improving smart food processing and smart agriculture through tools to reduce waste and enhance efficiency and sustainability. Despite the challenges, they are expected to be a game changer when combined with AI and IoT [1]. Agriculture faces increasing challenges such as population growth and food security, which makes AI technologies important. They help improve irrigation, and weed removal, reduce water and pesticide consumption, and increase crop yields and quality [2]. For practitioners and researchers, it is important and necessary to understand 3D printing in various fields and innovations in smart agriculture.

Results and discussion. 3D printing applications improve and increase the efficiency of smart agriculture. In addition, agricultural production increased by 20%. Therefore, it can reduce crop damage and water use by 30-40%. It also helps to reduce employment. Total energy consumption is reduced by approximately. The study uses 3D-printed sensors to collect real-time data. The sensors monitor and track soil conditions, nutrient levels, soil moisture, pH, and temperature. Modern technologies, including artificial intelligence tools, improve irrigation and pest management and enhance real-time monitoring. Robots help farmers with tailored guidance and recommendations.

In response to expansion exponential, Sensors and 3D technologies that support the Internet of Things IOT, such as sensors for smart agriculture sustainability. Developability and integration. As well as, the importance of privacy. And future research on improved green sensing units [3].

Tab 1. Smart agriculture in 3D printing applications, with references, associated performance indicators, and additional commentary. In addition to applications from specialized agricultural machinery to IoT devices, it highlights the diverse ways in which printing has enhanced agricultural practices. Each row gives details about the innovations and benefits that 3D printing contexts produce.

Conclusion. In conclusion, smart agriculture in 3D printing and crop processing can enhance human satisfaction and health. It reduces water and energy consumption for agriculture by a high percentage. Personalization of diets also enhances consumer satisfaction and health, and AI and IoT can boost agricultural production by a good percentage. Challenges include high costs and regulatory

compliance issues. However, it is necessary to cooperate to develop 3D printing technologies.

Table 1. Performance of 3D printing applications in smart agriculture.

Reference	Application	Performance	Others
[4]	components 3D-printed greenhouse	Special structures optimized for environmental control	
[5]	IoT integrated	Real-time data, and remote monitor	Improved decision making
[6]	Drone crop-based sprayers	Fine spray, reduced chemical	benefits Environmental
[7]	Smart irrigation systems	Water optimization	**Increased and** precise automation

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