

## A review on drone technology in agriculture

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ARTICLE INFO	ABSTRACT
<p><b>Review Article</b> Received on May 16, 2023 Revised on June 25, 2023 Accepted on July 13, 2023 Published on October 15, 2023</p> <p><b>Article Authors</b> Brajesh Kumar Lodhi, Ar. Ankita Singh, Divyanshi Singh</p> <p><b>Corresponding Author Email</b> <a href="mailto:brajeshlodhi@gmail.com">brajeshlodhi@gmail.com</a></p>	<p>Drones are unmanned aerial vehicles (UAVs) that can be controlled remotely by a pilot on the ground or flown autonomously by pre-programming a flight path. Drones have numerous applications in a variety of industries and can be used to improve efficiency and productivity. In agriculture, drones can be used for tasks such as crop monitoring, soil analysis and irrigation management. They can help detect water stress in crops, identify diseases and pests, estimate yield and maturity, and even map out weed populations for targeted spraying. This can help reduce input costs by minimizing the amount of water, seed and agrochemicals needed, as well as reducing the need for manual labor.</p>
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Drones are certainly a remarkable technological innovation that has a wide range of potential applications in various fields, including defense, industry and agriculture. In the defense sector, drones are used for reconnaissance, surveillance, and target acquisitions. In industrial sector, drones are used for task such as inspection, monitoring and surveying, they can be used to inspect infrastructure such as bridges and pipelines, monitor industrial sites for safety and security. In agriculture sector drones are used for crop monitoring, soil analysis, irrigation management and other task that can help farmers improve their efficiency and productivity (Ahirwar *et al.*, 2019). The application of drone technology shown in (fig. 1). The can used for precision agriculture, which

involves using data and technology to optimize crop yields while minimizing inputs such as water and fertilizers.

### Agricultural Application of Drone

The use of drones in agriculture can lead to increased efficiency, improved productivity, and more sustainable farming practices. Drones can help farmers optimize crop yields, cut expenses, and lessen the environmental effect of farming operations by giving real-time data and insights. Drones have become increasingly popular in agriculture due to their ability to collect high-resolution images and data quickly and efficiently. Some of the applications of drones in agriculture include:

## Crop Monitoring

Drones equipped with cameras and sensors have become increasingly popular in agriculture for crop monitoring. By capturing high-resolution images and data about crop health, growth, and yield, farmers can gain valuable insights into the status of their crops and identify any potential issues such as nutrient deficiencies or pest infestations. Drone-based crop monitoring can be more efficient and cost-effective than traditional methods such as walking through fields and manually collecting data (Debangshi, 2021).

## Precision Farming

Drones can be used for precision farming to apply inputs such as pesticides, fertilizers, and herbicides in a precise and targeted manner, reducing waste and increasing efficiency. Drone-based precision farming has the potential to revolutionize the agriculture industry by enabling farmers to be more efficient, sustainable and profitable (Mogili *et al.*, 2018).

## Soil Analysis

Drones can collect data various soil properties, including moisture content, temperature, pH, nutrient levels, and texture. By analyzing this data, farmers can gain insights into the health and quality of their soil, and make informed decisions about irrigation, fertilizer application, and other soil management practices (Ahirwar *et al.*, 2019).

## Planting

Some start-ups have developed drone-based planting systems that can plant seeds or seedlings in a highly efficient and precise manner. These systems use biodegradable pods or capsules filled with plant nutrients and seeds, which are released from the drone into the ground, drones can create detailed maps of the fields and precisely target where the pods are planted, ensuring that seeds or seedlings are spaced out properly and planted at the correct depth (Dutta and Goswami, 2020, Ahirwar *et al.*, 2019).

## Mapping

Drones can create highly accurate and detailed maps of farmland, including elevation, water features, and other topographical information. By using sensors and cameras, drones can capture high-resolution images of the terrain and create 3D models of the fields. Farmers can use these maps to identify areas that are prone to flooding or waterlogging, and take steps to improve drainage and prevent crop damage (Mustaffa *et al.*, 2020).

## Livestock Monitoring

Drones equipped with cameras and sensors can be used to monitor livestock herds, enabling farmers to keep track of their animals' health and behavior. By capturing high-resolution images and data, drones can provide farmers with valuable insights into the condition of their livestock, helping them detect any potential issues such as injuries or illnesses (Kalamkar *et al.*, 2020).

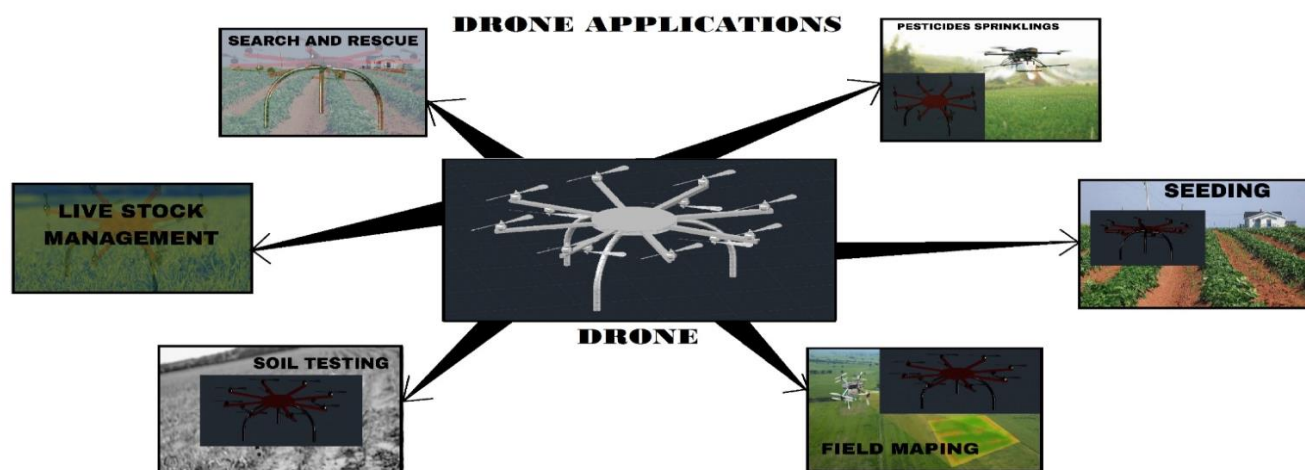


Fig 1. The application of Drone Technology

The use of drones in agriculture has been growing rapidly in recent years, which is expected to continue. The AUVSI reported that the market for agriculture drones has been growing at 58-92% annually. This expansion is being driven by the several benefits that drones may give to farmers, such as enhanced efficiency, lower costs and higher yields (Debangshi, 2021). Drone technology benefits in agriculture are their ability to reduce the need for pesticides and other agrochemicals, which can harm the environment and human health. Pesticide poisoning affects millions of workers each year, according to the WHO and many of them die.

Using ICTs in precision farming is an important trend in helping farmers improve their WUE, reduce costs, and increase their sustainability. Early warning systems for pests and diseases are another important use of ICTs in agriculture (Kalamkar *et al.*, 2020). Farmers can quickly detect signs of infestations or diseases using sensors and data analysis tools. Using drones to spray agrochemicals can help reduce the chemicals needed, improving WUE and Environmental sustainability. The brief review of some of the literature on drone technology in agriculture shown suggests that drones have great potential for improving efficiency, productivity and in (table 1).

**Table 1. Review of Literature drone Technology**

Author	Technology Used	Response	Findings
Kavoosi <i>et al.</i> (2020)	Rotocopter drone, GPS based navigation	Monitoring Soil residue Cover	LPT and weighting technique have power connection for CRC estimation. Satellite imaging performs better than drone photography due to availability of bands.
Mogili and Deepak (2018)	UAV types, Fixed wings, single rotor, Quad copter, Hexacopter, Octo copter	Precision of Drone in Agriculture	Locate the area where the insecticides will be sprayed. UAV sprinkling system uses GPS coordinates to spray pesticides on NDVI-detected regions. This might help to decrease water and chemical waste.
Wu <i>et al.</i> (2018)	Hexacopter, hybrid horn-dipole antenna mounted on drone	Soil Moisture Mapping	Soil moisture maps are consistent with elevation maps. Drone-based GPR prototype produces consistent results for soil moisture.
Dutta and Goswami (2020)	Quadcopter Hexacopter, octa copter	Role of Drone in Agriculture	Farmer can reduce inputs-water, pesticides, maintaining same output, it will be overcoming food shortages. Agriculture drone changes farmer’s ability to monitor and manage the key aspects in remote place. Drone, which started as a military technology, may end up better known as green technology.
Rani <i>et al.</i> (2019)	Seed Bombing Drone	Uses Green For Agriculture	Drones become integral element of agriculture can help farmers manage land and resources more sustainably.
Inoue <i>et al.</i> (2020)	Remote sensing Advance Quad copter Drone	Sensing of crops and Soils for smart Farming	Satellite-based diagnostic systems should be planned, developed and managed in collaboration.
Garcia <i>et al.</i> (2021)	Wireless sensor network, nodes	Soil monitoring in Precision agriculture	We presented a soil monitoring system that includes a soil humidity multisensory array, a soil temperature sensor, and a pH sensor. We investigated fields with various deployment options and vegetation kinds.
Gayathri Devi <i>et al.</i> (2020)	Quadcopter using UAV	Crop health monitoring, spraying pesticides, fertilizers	Spray pesticides and monitor crop with quadcopter to increase production. Reduce pesticide and fertilizer use while increasing crop output.
Kushwah, Jha and Kumar (2020)	Agriculture Drones	Drone technology in agriculture	Agriculture drones proved to ensure the development of sustainable agriculture if applied performed effectively. Agriculture drone regulatory frameworks are proven a positive approach concerning the importance of the growth of the agricultural field in India.

Joshi, Sasode & Chouhan (2020)	Wireless network	Sensor	Wireless network deployed for agriculture application	Sensor	Wireless sensor networks that detect soil factors, alter irrigation schedule, and soil management techniques help save a large amount of water underwater.
Chippa (2019)	Nanotechnology		Use of Nanotechnology in Agriculture		Nanotechnology has enormous promise since it can improve people's quality of life through applications in industries such as agriculture and food manufacturing.
Dileep <i>et al.</i> (2020)	Multi-Rotor, Fixed-Wing, Single-Rotor Helicopter, Fixed-Wing Hybrid VTOL		Different types of Drones used in agriculture		Drones are mostly employed in agriculture for information collection, reporting, physical activities, animal surveillance, crop information and pesticide spraying.
Panjaitan <i>et al.</i> (2022)	Hexacopter Drone		Enhance crop spraying efficiency		The agricultural outcomes suggest that drone uses can be beneficial as spray the crop, enhanced the effectiveness of nutrient and pesticide, the energy usage and trajectory accuracy have been investigated.
Karthik Prakash <i>et al.</i> (2022)	Quadcopter		Fire Detection & Spraying Pesticides		The UAV aircraft is used to identify fires in the forests at an early stage, allowing huge losses to be averted. • Spray pesticides and fertilizers on agricultural fields to minimize health risks caused by chemicals. This will also reduce labor costs.
Carabassa <i>et al.</i> (2021)	Fixed-wing drone, sensors to capture aerial data		Soil Monitoring	Erosion	To estimate the maximum and lowest total volume on recovered but degraded slopes and sedimentation.
Goodrich <i>et al.</i> (2023)	Drones with sensors	soil	Collecting soil data from mapping		For variable-rate irrigation applications to increase crop output while reducing pollution.
Mustaffa <i>et al.</i> (2020)	DJI-Phantom Drones and Multispectral camera	4 3	Mapping of soil physical property		Because pores inside the peat soil increased the quantity of water entering the soil, the moisture content of the peat soil altered the pH of the peat soil.
Karar <i>et al.</i> (2021)	F330 4-Axis Quadcopter	RC	Smart Soil testing & Agricultural Irrigation		Intelligent IOT- based irrigation system to track environmental data in an agricultural area. A drone has also been planned and partially used to support a smart irrigation system.
Hafeez <i>et al.</i> (2022)	Raspberry Pi module	3B	Precision Farming		Recent advancements in drone technology for precision farming.
Bertalan <i>et al.</i> (2022)	DJI Matrice M210 UAV + Zennuse XT2 camera		Soil water content (SWC) estimation		Demonstrate the effectiveness of UAV-based thermal and multispectral cameras in SWC mapping.
Yang <i>et al.</i> (2020)	DJI Mavic		Assessment of Water and Nitrogen Use Efficiencies		We proved that differences in the WUE and NUE genotypes and their influence on GY could be predicted using UAV-based remotely sensed multispectral characteristics.
Karan Kumar Shaw and Vimalkumar <i>et al.</i> (2020)	Octocopter		Drone for Spraying Pesticides, Fertilizers and Disinfectants		It can sanitize vast hotspot locations during the current COVID-19 Pandemic without physically visiting. Manual control can become autonomous with GPS technology and the option to return home automatically.
Rejeb <i>et al.</i> (2022)	Octocopter & Hexacopter		Bibliometric Analysis		Farmers may monitor their crops' health and nutritional requirements, insect infestations, ripening stage, and water status with technology.
Rahman <i>et al.</i> (2021)	DJI Phantom 4 pro		A study comparing use of drones in Agri.		UAVs are reducing the enormous quantity of fertilizer and chemical waste.
Reda <i>et al.</i> (2022)	Octocopter & Hexacopter		Pest Control Process		The proposed architecture is based on specific extracting features, the computed running time for in-depth extracting features, and the transfer learning development of deep learning models.

The literature on drone technology in agriculture sustainability in farming. By providing farmers with real-time data and insights about their crops and soil, drones can help farmers optimize their operations, reduce costs and minimize waste. However, there are also challenges associated with the use of drone in agriculture, such as has the needs for specialized skills and training, regulatory constraints, and technical limitation.

## Conclusion

Drones have the potential to revolutionize agriculture by providing farmers with new ways to monitor and manage their fields. By providing farmers with high-resolution images and data about their crops, drones can help them make more informed decisions about when to plant, water, fertilize, and harvest their crops. This can help farmers improve yields, reduce costs, and minimize waste, leading to more efficient and sustainable farming practices. Drones can also be used for precision farming, soil analysis, planting, mapping, and livestock monitoring by combining these capabilities, drones can help farmers optimize their operations, reduce their environmental impact, and improve their bottom line. The enhancing crop production and improving efficiency, drone technology can help farmers meet the growing demand for food while reducing the environmental impact of agriculture. This is especially important given the increasing population and limited resources of our planet.

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