

Drone Technology Transforming Agriculture

¹Dr. Pydi Raja Kumar, ²K Swaroop Paul Kumar, ³R.Sai Swetha

¹Dr. Pydi Raja Kumar, Faculty, Dept. of Sociology and Social Work, Acharya Nagarjuna University, Nagarjuna Nagar- 522510, Guntur, Andhra Pradesh, India.

²K Swaroop Paul Kumar, Research Scholar, Dept. of Sociology and Social Work, Acharya Nagarjuna University, Nagarjuna Nagar - 522510, Guntur, Andhra Pradesh, India.

³R.Sai Swetha, Research Scholar, Dept. of Sociology and Social Work, Acharya Nagarjuna University, Nagarjuna Nagar - 522510, Guntur, Andhra Pradesh, India.

Abstract: In recent years, drone technology has become increasingly popular in the agricultural sector. In this article, the advancement of drone technology was explored deeper into various aspects in agriculture, exploring its applications, benefits, challenges, and future prospects. This paper discusses the different types of drones and their uses in Agriculture sector. It also defines the different applications and future scope of drone technologies in Agriculture.

Keywords: Drone, crop health monitoring, spraying

INTRODUCTION

The global agriculture drones market size was valued at \$0.88 billion in 2020, and is projected to reach \$5.89 billion by 2030, registering a CAGR of 22.4% from 2021 to 2030. Drones offer farmers many benefits, including increased efficiency, improved productivity and reduced costs. However, there are concerns that farmers may be reluctant to adopt drone technology due to fear of losing their jobs or lack of knowledge and training. We can explore the benefits of drone technology in the agricultural sector and the challenges that may prevent farmers from adopting this technology. Agriculture, the backbone of human civilization, has made great progress over the years. As technology continues to advance, the integration of drone technology into agriculture has become a turning point. Drones, also known as unmanned aerial vehicles (UAVs), have revolutionized the agricultural industry by improving efficiency, precision and sustainability.

Drone technology: An overview

Drones are multi-purpose flying vehicles that are remotely controlled or automatically guided.

Originally developed for military purposes, drones today have many applications in many different industries, including agriculture. Agricultural drones are equipped with sensors, cameras and specialized data analysis software to perform a variety of tasks, from monitoring crop health to precise application of pesticides. Drones used in agriculture come in many different types, each designed for specific tasks and purposes. The choice of drone depends on the specific needs and goals of the agricultural operation. Here are some common types of drones used in agriculture:

1. Fixed-wing drones: These drones look like traditional aircraft and have fixed wings. They are known for their long-distance flying capabilities and their ability to cover large agricultural areas in a single flight. Fixed-wing drones are commonly used for mapping, surveying, and collecting data over large fields.

2. Multi-rotor drones: Multi-rotor drones, such as quadcopters and hexcopters, have multiple rotors that provide vertical lift and manoeuvrability. They are popular because of their ease of use and ability to stay in place, making them suitable for tasks such as reconnaissance, surveillance, and close-up inspection of crops.

3. Hybrid drones: Hybrid drones combine the features of fixed-wing and multi-rotor drones, providing both vertical take-off and landing (VTOL) capabilities as well as effective coverage covering larger areas. These drones are very versatile and can be used for many different agricultural applications.

4. Unmanned helicopters: Unmanned helicopters are equipped with a single rotor or multiple rotors that provide lift and control. They are suitable for jobs that require stability such as spraying pesticides and

fertilizers for plants. Unmanned helicopters can be equipped with specialized spray equipment.

5. VTOL drones: Vertical take-off and landing (VTOL) drones are capable of taking off and landing vertically like a helicopter, but can switch to fixed-wing flight mode for coverage effective. VTOL drones are versatile and can be used for both mapping and crop management tasks.

6. Sensor drones: Some drones are designed primarily to collect data using various sensors, such as multispectral, thermal, or LiDAR (Light Detection and Ranging). These sensors help collect valuable information about crop health, soil conditions and terrain. Sensor drones are commonly used in precision agriculture.

7. Unmanned aerial vehicle spraying: Dedicated agricultural drones equipped with spraying systems are used to precisely spray pesticides and fertilizers. These drones can precisely target specific areas, reducing chemical use and environmental impact.

8. Mapping and surveying drones: These drones are equipped with high-resolution cameras and LiDAR sensors to create detailed 3D maps, terrain models and crop health maps. They are valuable for surveying, drainage planning and resource management.

9. Mobile drones: Rover drones, also known as ground drones or unmanned ground vehicles (UGVs), are equipped with wheels or tracks and are designed to operate on the ground. They may navigate fields to collect data or perform tasks such as soil sampling.

10. Drone swarm: Swarm drones are made up of several small drones that can operate together as a group. They are used for large-scale data collection, covering large agricultural areas simultaneously. Drones can improve the efficiency of tasks such as crop monitoring and pest control.

The choice of drone type depends on factors such as farm size, specific agricultural tasks needed, budget constraints and available technology. Agricultural professionals and farmers often choose the type of drone that best meets their operational needs to maximize efficiency and productivity.

Drone application in agriculture:

1. Monitor and evaluate plant health: One of the main uses of drones in agriculture is monitoring crops and assessing their health. Drones equipped with thermal and multispectral cameras can capture high-resolution crop images, allowing farmers to identify early signs

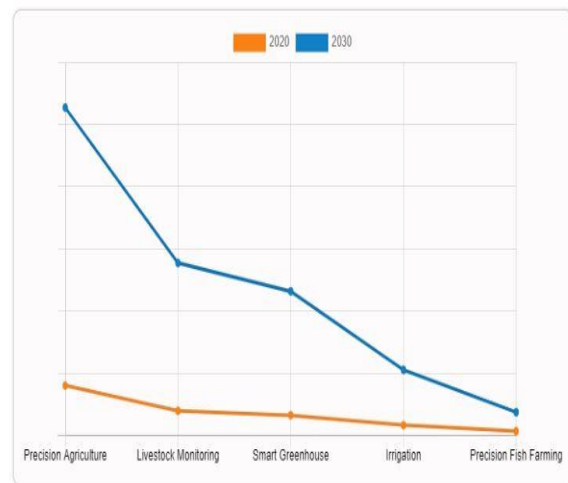
of stress, disease or nutritional deficiencies. This real-time data allows farmers to take timely corrective actions, thereby reducing crop losses and optimizing yields.

2. Precision agriculture: Drones play a central role in precision agriculture by enabling precise and efficient resource management. They can collect data on soil moisture, nutrient levels and crop growth rates, helping farmers make data-driven decisions about irrigation, fertilization and pesticide use. This not only maximizes productivity but also minimizes the environmental impact of farming.

3. Use of pesticides and fertilizers: Drones are capable of spraying pesticides and fertilizers with precision, minimizing waste and minimizing the risk of over use or contamination. This targeted approach improves crop protection while reducing the economic and environmental costs associated with excessive chemical use.

4. Spraying plants: In addition to spraying pesticides and fertilizers, drones can also be equipped with specialized spraying equipment to fight weeds and pests. They can access hard-to-reach areas in the field and apply treatments with unparalleled precision, minimizing damage to non-target organisms.

5. Crop screening and mapping: Drones can create detailed 3D maps of fields, helping farmers identify variations in terrain and soil composition. This information facilitates optimal planting, drainage management and land use planning. In addition, it also allows for efficient allocation of resources and manpower.



Drone Technology demand Forecast, 2020–2030
Source: Agriculture Drones Market

Agricultural drones are unmanned aerial vehicles enhanced with water-spraying drones, designed to optimize agricultural performance, crop production, and growth monitoring. Additionally, drone sensors and digital imaging capabilities aim to give farmers a richer picture of their fields. Additionally, abrupt global climate changes are creating new levels of complexity in the agricultural sector, increasing the need for advanced solutions such as agricultural drones to improve productivity. The aerial view provided by drone farming can reveal various problems such as soil changes, irrigation problems, and fungal infections. It is a set of instructions used in agriculture to study crops to quickly identify problems. Additionally, drones globally have revolutionized the agriculture industry by increasing efficiency, saving costs, and delivering higher profits. The global agricultural drone market is still in its infancy; however, technological advancements in the drone sector are expected to fuel the growth of the agricultural drone market in the coming years.

The agricultural drone market share is expected to witness notable growth during the forecast period, due to increased venture funding for drone deployment in the agricultural industry globally. Furthermore, high adoption of precision farming solutions will drive market growth during the forecast period. Additionally, the growing need to reduce costs associated with human error is expected to drive analysis of the agricultural drones market. However, increasing government regulations related to drones globally is expected to restrain the market growth. The growth of automation in agriculture and agricultural industries offers many growth opportunities for drone applications. The agricultural drones market is segmented based on supply, components, and applications. On the basis of offering, the market is divided into hardware and software. The hardware segment dominated the market in terms of revenue in 2020 and is expected to follow the same trend during the forecast period. Based on components, the market is divided into cameras, batteries, navigation systems and others. The camera segment was the largest revenue contributor in 2020 and is expected to gain significant market share during the forecast period. Based on equipment type, the market is divided into fixed wing, rotary wing and hybrid wing. The fixed-wing segment dominated the market in terms of revenue in 2020 and is expected to follow the same

trend during the forecast period. From application, the market is fragmented between precision agriculture, livestock monitoring, smart greenhouses, irrigation and precision fish farming. The agricultural drone market share in the precision agriculture segment peaked in 2020 and is expected to grow at a high CAGR from 2021 to 2030.

By region, agricultural drones market trends are analysed in North America (US, Canada and Mexico), Europe (UK, Germany, France, Italy and Rest of Europe), Asia - Pacific (China, Japan, India, Korea and the rest of Asia-Pacific) and LAMEA (Latin America, Middle East and Africa). North America is expected to grow at the highest rate during the forecast period. North America, especially the United States, remains a significant player in the global agricultural drone market. The country's major institutions and government entities are investing heavily in technology.

Benefits of Drone technology in agriculture:

Drones can be used for a variety of tasks in the agricultural sector, including crop mapping, soil analysis, irrigation and pest control. Here are some key benefits of using drones in agriculture:

1. Increase efficiency: Drones significantly reduce the time and effort required for crop monitoring and management. Drones can cover large areas of land quickly and efficiently, allowing farmers to collect data and monitor crops more effectively. This can help identify problems at an early stage, leading to faster and more effective interventions. This efficiency translates into cost savings and improved productivity.
2. Improve accuracy: The precision provided by drones is unmatched. They can apply inputs with centimetre precision, reducing waste and improving crop health. This precision also contributes to more sustainable agriculture practices.
3. Cost savings: Drones help reduce operating costs by optimizing resource usage. Farmers can adjust their actions based on accurate data, reducing the need for excess water, pesticides and fertilizers. Over time, these savings can be significant.
4. Environmental Benefits: Drone technology promotes sustainable agriculture by minimizing the environmental impact of farming practices. Reduced chemical usage and efficient resource management contribute to soil and water conservation, reduced pollution, and overall environmental health.

5. Improved Crop Yield and Quality: By identifying and addressing issues early in the crop growth cycle, drones help maximize yield and improve the quality of agricultural products. This, in turn, can bring higher profits to farmers.

Challenges and Considerations: While the benefits of drone technology in agriculture are clear, some challenges and considerations need to be addressed:

1. Cost: The initial investment in drones and related equipment can be huge, which can limit access for small farmers. However, as technology advances and adoption increases, costs are likely to decrease.

2. Regulation and Compliance: The use of drones in agriculture is subject to regulatory frameworks that vary by country. Farmers need to navigate these regulations, including licensing requirements and aviation restrictions.

3. Data Security and Privacy: Collecting and storing agricultural data generated by drones raises concerns about data security and privacy. Farmers must ensure that sensitive information is adequately protected.

4. Skills and training: Operating drones and interpreting data requires a certain level of technical skill. Farmers and agricultural professionals may need training to use drone technology effectively.

While drones offer many benefits to farmers, there are also challenges that can prevent them from adopting this technology. Many farmers fear that the adoption of drone technology will lead to job losses because fewer workers will be needed to perform manual labour on the farm. Farmers may not have the knowledge or training to use drones effectively. This can make it difficult to adopt the technology as they may not have confidence in their ability to use it. Drones can be expensive and many farmers may not have the financial resources to invest in this technology. There may be regulatory barriers to the use of drones in agriculture, which could make it difficult for farmers to adopt the technology. The adoption of drone technology in India's rural agriculture sector is still in its early stages. While there is some interest in the technology, there are also concerns about job losses and a lack of knowledge and training. However, efforts are underway to address these challenges and encourage the adoption of drone technology. One of the key initiatives is the Digital India campaign, which aims to provide digital infrastructure and connectivity to rural areas. This

initiative focuses on training and education, which can help address farmers' lack of knowledge and training.

Additionally, there are a number of organizations and initiatives focused on promoting the use of drone technology in agriculture. For example, the Indian Council of Agricultural Research (ICAR) has established the Centre for Precision and Agriculture Technology, which focuses on promoting precision agriculture technologies, including drones.

Future Prospects:

The future of drone technology in agriculture holds immense promise. As technology continues to advance, drones are expected to become more accessible, affordable, and capable. Here are some future prospects:

Autonomous Drones: Advancements in Artificial Intelligence (AI) will enable drones to operate autonomously, making them even more efficient and user-friendly.

Integration with other technologies: Drones will likely be integrated with other emerging technologies such as IoT (Internet of Things) sensors, block chain and big data analytics, creating a transparent and connected agricultural ecosystem.

Customization: Farmers have access to specialized drones tailored to their specific needs, from small-scale organic farming to large-scale commercial farming.

Environmental monitoring: Drones can play an important role in monitoring the effects of climate change, deforestation and wildlife conservation, in addition to their role in traditional agriculture.

There is a lot of opportunity for growth in the agricultural drone sector. As technology continues to improve, crop imaging will also need to improve. With crop data recorded by drones, farmers can analyse their crops and make informed decisions on how to proceed, providing accurate crop information. Agricultural production analysis and adjustment software has potential for development in this market. Farmers will fly drones over their crops, pinpoint problems in a specific area, and take the necessary steps to fix the problem. This gives farmers time to focus on general production tasks instead of spending time monitoring their crops. Additional applications include livestock tracking, fence surveys, and plant pathogen monitoring. The cost of purchasing and maintaining modern drones makes them unaffordable for small

farms in developing countries. Pilot programs in Tanzania aim to reduce these costs by producing agricultural drones that are simple and robust enough to be repaired locally. Drones have great potential to transform Indian agriculture.

With the advancement of technology in the future, the Drone production will become economical. Youth are not attracted to agriculture due to difficulties work and the work this entails. Involvement of drones can fascinate and encourage young people towards agriculture. Drones provide high-quality, real-time aerial imagery compared to satellite images of agricultural areas. Also, Application to locate weeds and diseases, identify soil properties, detecting differences in vegetation and Production of accurate elevation models is currently underway possible. Thanks to drones. Drones will enable farmers to learn more about their field. Therefore the farmer will produce more food while using less Chemical products. Almost all farmers already use drones has gained some form of advantage. They can earn more Efficient use of their land, destroying pests before they do destroys entire plants, adjusts soil quality to improve growth In problem areas, improve irrigation of diseased crops heat stress and monitor fires before they get out of control. Therefore, drones can become an indispensable part of agriculture in the future by helping farmers manage their fields and resources in a better and more sustainable way.

CONCLUSION

The integration of drone technology into agriculture represents a significant step forward in the development of the industry. Drones provide farmers with valuable data, increase efficiency, reduce costs and promote sustainable agricultural practices. Although challenges remain, technological advances and continued regulatory adjustments are likely to accelerate the widespread adoption of drones in agriculture. As we look to the future, it is clear that drone technology will continue to transform agriculture, contributing to food security and environmental sustainability globally. Drones bring many benefits to farmers in the agricultural sector, including increased efficiency, improved productivity and reduced costs. However, there are also concerns that job losses and lack of knowledge and training could hinder farmers from adopting the technology.

Although the adoption of drone technology in rural India is still in its early stages, efforts are underway to address these challenges and promote drone usage in agriculture. It is important that farmers understand the potential benefits of this technology and receive the training and support needed to use it effectively.

In conclusion, the application of drone technology in the agricultural sector has the potential to change the way farmers manage crops and improve productivity. While there are still challenges to overcome, such as concerns about job loss and lack of knowledge and training, initiatives are also underway to promote the use of this technology and provide support to farmers who wish to adopt it. It is essential that farmers and policymakers work together to ensure that the benefits of drone technology in agriculture are realised, while addressing any concerns or challenges. Consciousness can arise. In doing so, we can help create a more sustainable and efficient agriculture industry that benefits both farmers and consumers. Demand for drones in agriculture is driven by their potential to increase efficiency, improve productivity and reduce costs. However, it should be noted that the adoption of drone technology in agriculture may vary by region, depending on factors such as farm size, available technological infrastructure and Regulatory considerations. In addition to the growing demand for drones in agriculture, advances in drone technology, such as longer flight times, greater payload capacity, and improved data analysis capabilities improvements, which will likely further enhance their utility in agricultural production in the coming years.

REFERENCE

- 1) "Commercial Operations Branch – Part 107 UAS Operations". www.faa.gov. Retrieved 2020-07-28.
- 2) Dukowitz, Zacc (2020-02-25). "No Flying Allowed: The 15 Countries Where Drones Are Banned". UAV Coach. Retrieved 2020-07-28.
- 3) "Civil drones (Unmanned aircraft)". EASA. Retrieved 2020-07-28.
- 4) Bernard, James (2018-03-12). "Africa Farming Problems Aided With Drone Technology". Drone Addicts. Archived from the original on 2018-06-29. Retrieved 2018-10-27.
- 5) Ehrenberg, Rachel (2018). "Eyes in the sky: 5 ways drones will change agriculture". Knowable

- Magazine. doi:10.1146/knowable-101118-3. S2CID 134431340.
- 6) "Innovation in Africa: what next?". Africa Times. 2016-02-10. Retrieved 2020-12-28.
 - 7) Anderson, Chris (2014). "Agricultural Drones". MIT Technology Review. 117 (3): 58–60. ProQuest 1534143322.
 - 8) Bring in the drones: flying robots could be a valuable tool for crop surveillance. (n.d.) The Free Library. (2014). Retrieved Sep 18 2016
 - 9) Farmers and Ranchers Will Soar with Agricultural Drones. (2015, April 28). Farm & Ranch Guide. Retrieved September 16, 2016
 - 10) "Global Market for agricultural drones is expected to reach \$3.69 billion by 2022; Finds New Report" (Press release). M2. 14 April 2016. ProQuest 1780742295.
 - 11) Van Blyenburgh P. UAVs: an overview. Air & Space Europe. 1999; 1(5-6):43-47.
 - 12) Bendig J, Bolten A, Bareth G. Introducing a low-cost mini-UAV for thermal-and multispectral-imaging. Int.Arch. Photogramm. Remote Sens. Spat. Inf. Sci. 2012; 39:345-349.
 - 13) Anthony D, Elbaum S, Lorenz A, Detweiler C. On crop height estimation with UAVs. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2014), 2014, 4805-4812.