The Pharma Innovation Journal 2022; 11(12): 279-286

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 279-286

www.thepharmajournal.com
Received: 09-09-2022
Accepted: 17-10-2022

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An innovative drones technology in agriculture: A review

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Abstract
One of the key technological advancements for boosting crop output in Indian agriculture is the use of drones for farming. New technologies make it possible to collect environmental data in real time. Drone technology with remote sensing, machine learning, and artificial intelligence (AI) characteristics is becoming more popular. There are various ways growers can employ drone-based aerial intelligence while managing their crops, regardless of whether they have adopted precision agriculture equipment on their farm. By acquiring high spatial and temporal resolution photos, the unmanned aerial vehicle (UAV) can be utilized in a range of applications linked to crop management. The monitoring of the crops and the requirement to apply pesticides and fertilizers at the precise time and position of the plants is a crucial factor in raising the production of the crops. Unmanned aerial vehicles (UAVs) can be employed in the agriculture industry, which will cut down on the time and dangerous consequences that pesticide and fertilizer applications. The use of UAVs for agricultural monitoring and pesticide spraying. For boosting agricultural output, precision agriculture has undergone far too many developments in the modern period. More than 70% of the rural population relies on agriculture, particularly in developing nations like India. Due to various pressures, that lower the productivity of the crops, the agricultural areas suffer drastic losses. In order to improve the quality and productivity of crops, pesticides and fertilizers are utilized, but they also have an impact on human health. Drone technology is utilized to reduce human labour in a variety of agricultural operations, such as the identification of pest presence, the application of UREA and fertilizers, and others. To prevent human health issues when applying pesticides manually, UAV aircraft are employed to spray the chemicals. With the ability to make decisions in days rather than weeks and the promise of major cost reductions and productivity increases, these technologies are anticipated to transform the agricultural industry. Such choices support the four pillars of precision agriculture, which include applying the correct practice at the right place, at the right time, and with the right quantity. They also enable the effective application of farm inputs. Drones have the power to completely change Indian agriculture. Drones have the potential to interest young people and inspire them to pursue agriculture. Therefore, the only workable solution to this urgent request for higher agricultural production is drone technology and powerful picture data analytics capabilities.

Keywords: Drones, spraying, unmanned Arial vehicles (UAV) aircraft, remote sensing, artificial intelligence (AI), crop monitoring, precision agriculture, sustainable agriculture

Introduction
“The adoption of modern technologies in agriculture, such as the use of drones or Unmanned Aerial Vehicles (UAVs) can significantly enhance risk and damage assessments and revolutionize the way we prepare for and respond to disasters that affect the livelihoods of vulnerable farmers and fishers and the country’s food security.”

(Jose Luis Fernandez),
FAO Representative in the Philippines

DRONE (Dynamic Remotely Operated Navigation Equipment), also known as UAV, is a device that may be flown manually using radio signals via a remote control or smartphone app or automatically using GPS coordinates and autopilot to follow a predetermined course. The Indian government has declared in recent statements that it is focusing on boosting drones in the agricultural sector. The government of India intends to utilize "Kisan" (Hindi for farmers) drones to expand the nation's agricultural industry, according to the federal budget for 2022-2023. Insecticide (Kedari *et al.* 2017) [18] and nutrient spraying, crop evaluation, and digitization of land records are all applications for drones that will be pushed.

Since large-capacity drones may be used to transport produce directly from fields to markets, including fruits, vegetables, and fish, they have the potential to spark a revolution (Rani *et al.* 2019) [28]. Farmers and fishermen will make more money because these products will be delivered directly to the market with little to no harm and in a shorter amount of time. By 2050, 9 billion people are expected to live on the planet, according to researchers. Agricultural consumption is said to rise concurrently by around 70%. Because of its benefits, drone technology with remote sensing (Colomina and Molina 2014) [5], machine learning, and artificial intelligence (AI) characteristics is becoming more and more popular (Aditya *et al.* 2016) [1]. The federal government's online "Digital Sky Platform" acknowledges the significance of unmanned aerial vehicles (UAVs), machine learning, and artificial intelligence. India's drone start up ecosystem has taken advantage of this chance to advance its technological capabilities (Meivel *et al.* 2016) [22]. There are various ways growers can employ drone-based aerial intelligence while managing their crops, regardless of whether they have adopted precision agriculture equipment on their farm (Zhang and Kovacs 2012) [33]. A drone can be used to scout hundreds, and even thousands, of acres in a single day. As they fly, they may collect visual and multispectral data to count the number of stands accurately even before the plants have even begun to emerge. They are able to manage nutrient intake, monitor crop progress, and decide when to replant using high-quality, multi-sensor imaging and analytics.

In India, more than 60% of people are employed in agriculture. The Indian economy relies on it as its skeleton. By ensuring that farmers can cultivate their land safely, agriculture may be more productive and efficient. The numerous processes, such as pesticide application (Hafeez *et al.* 2022) [13] and fertilizer application, are crucial. Even though pesticide spraying is now required, it still proved to be risky practice for farmers. Particularly while spraying urea, farmers take a lot of safety precautions, including donning the proper clothing, masks, and gloves. Any negative impact on the farmers shall be avoided. Avoiding pesticides entirely is also not feasible because the desired outcome must be achieved. Therefore, using robots in these situations provides the greatest answers for these types of issues, along with the necessary productivity and efficiency of the product. A WHO (Global Health Organization) survey indicates that over 3 million workers are thought to be poisoned by pesticides each year, resulting in 18,000 fatalities. This technique uses an autonomous fertilizer sprayer to spray pesticides over a larger area more frequently than is typical, hence reducing the negative effects of the chemicals on people. Essentially, this device is a spraying mechanism mounted on a quad copter frame. The chemicals are sprayed using this model in regions that are difficult for humans to reach. The universal sprayer system uses a universal nozzle to spray both liquid and solid materials (Mone *et al.* 2018) [24].

Drones used in agriculture to help enhance crop production and track crop growth are known as agricultural drones (Joshi 2020) [16]. Farmers are able to use these drones to assist them to collect their farms thanks to the usage of modern sensors and digital imaging capabilities. Such technology may collect data that can be used to increase agricultural yields and farm productivity (Shaw and Vimalkumar 2020) [30] Drones for agriculture provide respite for contemporary farmers. The use of drone technology can lessen the need for manpower and resources. Drones can also be used by farmers to get aerial views of their land. In 1986, the Japanese government used drones for the first time to identify the reasons for the decline in rice farmers after seeing their potential. The use of UAV for pest management in Japanese rice fields accounts for about 35% of the total (Valentin *et al.* 2021) [32]. The Ministry of Agriculture, Forestry, and Fisheries is currently putting a lot of effort towards drone use in agriculture.

Drones can be used for a variety of purposes, including photography, agriculture, and even warfare, but their main capabilities are flying and navigation (Muggeridge 2017) [25]. Drones have a power source that enables them to fly, such as a battery or fuel. In order to reduce weight and improve manoeuvrability while in flight, drone frames are often composed of lightweight composite materials. Drones need a controller, which an operator may remotely launch, pilot, and land. In order to connect with the drone, operators employ Wi-Fi and radio waves (Kurkute *et al.* 2018) [19].

History

An unmanned aircraft is what we refer to as a drone technologically. They are more properly called as unmanned aerial vehicles (UAVs) (Simelli and Tsangaris 2015) [31] or unmanned aircraft systems (UASes), and they can weigh between 2 and 20 kg. A drone can be thought of as a flying robot that can be remotely controlled or that can fly on its own using software-controlled flight plans in their embedded systems in conjunction with on board sensors and GPS. Austria's 1849 attack on Venice with unmanned balloons carrying explosives was the first time the idea of drones was introduced. On September 12, 1917, the Hewitt-Sperry Automatic Airplane, often known as the "flying bomb," made its first flight during World War I, introducing the idea of an unmanned aircraft. John Clervaux Chaytor, who used a hot air balloon with movable tethers to disperse seeds across a drowned valley bottom in Wairau, New Zealand, on the family farm's "marshlands," is credited with using aerial agriculture for the first time in 1906, according to a number of unreferenced sources. The US Agriculture Department and the US Army Signal Corps research station in Ohio employed a plane for crop dusting shortly after that, in 1921 (Johnson 2002) [17].

Drones are more widely available than ever before because to a growing number of models that offer longer flight lengths, bigger cargo capacities, and the ability to fly in various weather situations. It can be difficult to choose the ideal drone for a particular application. In order to acquire data more quickly, safely, and accurately, Precision Hawk assists agricultural professionals in choosing the best drones and payloads for the specific crops that interest them. A farmer may easily run a variety of analytical reports, validate stand establishment, and monitor crop health and yields using Precision Analytics Agriculture, a cloud-based software platform created exclusively for agriculture professionals.

We suggest the following drones for agriculture

1. **Firefly6 PRO/S:** This American-made fixed-wing drone travels farther and more quickly than multi-rotor technology. 600 acres of crops can be covered in a single deployment. Launch swiftly and safely from any location with a Vertical Take-off and Landing (VTOL) form factor that only needs a 10 x 10-foot deployment area.
2. **DJI Matrice 200 V2:** Designed to fly anywhere there are

crops, the tough M200 is built to last. An enclosed design offers weather and water resistance so you may fly in a variety of conditions, so you can deploy your drone in below-freezing temperatures or strong winds. To simultaneously deploy various sensor payloads, such as optical and thermal sensing, use the dual gimbal.

3. **DJI Phantom:** The DJI Phantom series enables farmers, agronomists, and researchers of various income levels to integrate drone technology into their agricultural operations at a more reasonable price point. The sophisticated camera on this drone provides unmatched image quality and object detection in five directions for a smooth flight.

Types of drones

There are three types of drones following

1. **Fixed-wing drones:** A motor and propeller serve as the propulsion system for fixed-wing drones, which are composed of a stiff (non-movable) wing, a fuselage (the main body of the aircraft), and tails. Their ability to fly at higher speeds for longer periods of time, covering a wide range of potential habitats, is a benefit (ex: jungle, desert, mountain, maritime, etc.). However, this disadvantage is compounded by the fact that these drones cannot hover and must use a runway or launcher to take off and land.
2. **Rotary wing drones:** These drones are known as rotatory wing drones because they use propeller- or rotary blade-based propulsion systems. These drones, as opposed to fixed-wing types, can fly in all directions, both horizontally and vertically, as well as hover and have excellent mobility. They are the ideal drones for surveying difficult-to-reach places because of their qualities (pipelines, bridges). The continual rotation of the rotor blades gives them a lift similar to that of helicopters. However, these also have the drawbacks of poor speed and limited range.
3. **LTA & tethered systems drones:** Their management of them is difficult and they are rarely employed in agriculture.

Classification of drones

According to size

1. **Very small drones:** They can be created in a standard size range that ranges from a giant bug to a unit that is 50 cm long. Mini drones and Nano/Micro drones are the two most popular types of drones in this category. Due to their small size and light weight, nano drones are commonly utilized for biological surveillance and welfare.
2. **Mini drones or small drones:** They are slightly larger than micro drones, therefore they can travel beyond 50 cm but can only have a maximum dimension of 2 metres. Few designs in this category can have rotary wings, whereas many are based on the fixed wing type. They lack power because of their diminutive size
3. **Medium drones:** Although they are smaller than light aircraft, this category of drones includes models that are too heavy to be handled by a single person. These drones have an average flight time of 5 to 10 minutes and can carry up to 200 kg of weight. UK watch keeper is one of the most prominent designs in this group.
4. **Large drones:** The majority of large drone applications are for military purposes, and their size is somewhat comparable to that of an aeroplane. These drones are typically used to capture areas that conventional jets cannot reach. They are the primary tool used in surveillance applications. Depending on their flying capabilities and range, users can further divide them into many groups.

According to Altitude

1. **Low altitude system:** They may complete one mission while flying between 105 and 200 meters in the air, within the pilot's line of sight and its boundaries.
2. **Medium altitude systems:** operate in a similar area to that of air traffic with little regard for the civil or scientific communities.
3. **High altitude systems:** Mostly fixed-wing aircraft, powered by the Sun.

Components of a drone

Different multi-copter models have parts that offer strength and endurance. A multi copter's qualities and kind are determined by its components (Maurya 2015) [21]. The following are the crucial parts that make up an unmanned aerial vehicle (Sarghini and De Vivo 2017) [29].

Frame

The frame is the fundamental framework on which the remainder of the construction is constructed. It serves as the UAV's skeleton, so to speak. It must be as light as possible to save power consumption while in flight, but sturdy enough to withstand collisions and mishaps and enhance the payload of the UAV. The motors and other equipment are supported by the frame in such a way that they maintain stability throughout the flight and keep the vehicle level. The multi-copter is defined by a number of different frame types. Tricopter, quadcopter, hexacopter, single copter, and octocopter frame types are the most popular.

Propellers

The lifting of the UAV is accomplished by the propellers. The diameter and pitch of the propellers are the two properties of the propellers. The distance covered by a propeller during one revolution is known as its pitch. Because it produces greater torque and the motors do not have to work as hard to carry high weights, a propeller with a lower pitch value can lift heavy loads. As a result, the motors will use less battery power and the UAV's flying endurance duration will extend. While using propellers with higher pitch values would result in less torque being produced, which would result in turbulence. The quantity of air that contacts the propellers surface determines how efficiently the UAV flies. Large-diameter propellers are more effective because they will make more contact with the air than smaller-diameter propellers. On either side of a multi copter are motor units called propellers. Tricopter blades or motor units have three blades each, quadcopters have four blades each, hexa copters have six blades, and so on. Make sure to inspect the propellers of a certain drone or quadcopter before making an investment if you're shopping for a UAV for sale or drones for sale. For the best stability and vibration reduction while building your own quad copter, always look for low pitch propellers.

Motor

It is crucial that you think carefully when choosing high-quality motors for your drones because they are one of the main components of the UAV and determine the choice of the entire power system. A brushless motor is the most popular kind of motor used in multi copters. Brushless DC motors have the benefit over brushed DC motors in that they are electronically commutated and do not require brushes for that purpose. Because of this, they offer excellent speed-to-torque characteristics, high efficiency with silent operation, and a very large speed range with longer life.

Flight controller

The UAV's intelligence is controlled by a flight controller. It executes all the mathematical and logical calculations based on the information input by the various sensors and user commands, then sends the signal to the ESC (electronic speed controllers used to control the speed of motors), which adjusts the speed of the motor so that the UAV is balanced and in control. The flight controller is frequently referred to as the aerial vehicle's brain by enthusiasts of multi-copter aircraft. There are several different kinds of flight controllers, including Naza, KK, WKM, Ardupilot, and Rabbit. But these flight controllers may be too many to begin with. You can substitute a gyro sensor for a flight controller in your personal DIY quad copter project. You can update your outdated quad copter once you are familiar with all of the features and capabilities of a flight controller.

Power source

It is the source of power for UAVs and can take many different forms, including fuel, electricity, and petroleum. The majority of multi-copter experts advise lithium batteries over gasoline and oil since the latter require more space for storage and are more expensive. In contrast, electrical power systems like batteries are very inexpensive, take up less space, and have a higher energy capacity than other batteries.

Application of drones in agriculture

Agriculture drones give farmers the ability to adapt to particular conditions and help with irrigation, crop scouting, crop treatment, field soil analysis, and crop damage assessments. Any crop in any place may be monitored with drones. Utilizing drone technology can increase crop yields, reduce time, improve long-term performance, and make land management more sustainable.

Soil and field analysis

Drones using remote sensing cameras gather information from the ground using the electromagnetic spectrum to examine the soil and field. The range of wavelengths that various elements reflect can be utilized to distinguish between them. Drones collect unprocessed data and turn it into usable information using algorithms. They can therefore be utilized in many framing applications, such as tracking the following variables:

- Crop health includes damage from pests, nutrient deficits, and color changes as a result of pest infestation.
- Leaf area, treatment efficacy, phenology, and yield catalogues for vegetation.
- Plant development includes plant height, LAI, and plant density.
- Plant inspection: stand number, plant size, field data, compromised field, and planter skips.
- The amount of water needed will depend on the climate, and any areas of the field or orchard that are water-stressed need to be watered.
- Research on the availability of nutrients in the soil for managing plant nutrition with the use of this knowledge, farmers may choose the most effective planting, crop management, and soil management techniques (Dutta 2021) [8].

Seed sowing and planting trees

Crops can be planted using drones, which will decrease labour costs and lessen human labour-intensive tasks. Drones can save fuel and prevent the emission of toxic gases created during fuel exhaustion when operating tractors in the field because there would be no need for tractors to plant crops in the field. By launching biodegradable seed pods or seed bombs, drones can be utilized to plant trees or crops in off-the-grid locations (Dutta 2020) [9].

Weed identification

The presence of weeds in the field can be determined using drones (Huang *et al.* 2018) [15]. So that they do not compete with the primary crop for resources, these weeds might be swiftly eradicated from the field (Beriya 2022) [4].

Agricultural Spraying Process

The health of the crop now depends on the application of herbicides to eradicate pests and undesirable plants like weeds. Drones are able to transport reservoirs of the right size that can be loaded with plant growth regulators (PGRs), insecticides, herbicides, fertilizers, and other chemicals for speedier application (Hafeez 2022) [13]. Because of the height of the crop, manual spraying operations can occasionally be quite difficult. Therefore, smart farms utilize drones to spray, minimizing the chance that people will come into touch with fertilizers, pesticides, and other harmful substances (Pathak *et al.* 2020) [26]. Spraying can be done on a 1 ha field in less than 40 minutes thanks to equipment that is up to five times faster than conventional apparatus. Pesticides are saved by 30%.

Crop health assessment

Crop health can be tracked over time and the effectiveness of corrective treatments can be observed by utilizing drones fitted with sensors that can scan crops using visible and near-infrared light. This can be configured to identify specifics like the NDVI, water stress, or a deficiency in particular nutrients in crops (Pravin and Munde, 2019) [27]. Farmers can use data from sophisticated sensors provided in 2D or 3D form to better understand and discover new ways to boost crop yields while preventing crop damage. This data also acts as proof for farmers or government agencies seeking crop insurance or obtaining an estimate in the future (Altas *et al.* 2018) [3].

Planning and monitoring of irrigation

Drones with thermal cameras and remote sensing capabilities can aid with irrigation-related issues and can divide areas into several moisture regimes (Devi *et al.* 2020). This aids in carefully planning the irrigation. The FAO's drones in the Philippines are outfitted with photogrammetric and navigational tools that have a ground resolution of up to 3 cm (Pravin and Munde 2019) [27].

Analysis of plant emergence and crop counts

Using drones and high-resolution data mixed with machine learning algorithms, unmanned aerial vehicles (UAVs) are a practical, quicker, and more affordable tool for acquiring data on crop emergence, guiding replanting decisions (Malenovsky *et al.* 2017) [20], and assisting with yield prediction (MLAs). This technology uses data collected by drones and photogrammetry to provide output that is 97% accurate. Using drones with LiDAR sensors, it is possible to calculate the change in tree/crop biomass based on differential height measurements, which is used to calculate the amount of lumber produced in forests (Mogili *et al*. 2018) [2].

Prevention of disasters

In order to aid in disaster risk reduction (DRR) activities, FAO has collaborated with national colleagues to build methods for using drones to collect data. The modeling systems with analytics capabilities are then used to import these useful data, producing illuminating results. Such information can assist in better organizing government disaster relief and response efforts and can also benefit rural areas with high-quality, credible recommendations. Drones force ground personnel to take instant action, doing so considerably more quickly than they could manually. By up to 44.46%, drones can speed up the response to a tragedy.

Conserving wildlife

Livestock may be tracked, inspected, and watched from a variety of angles using drones equipped with infrared cameras. The study of wildlife and forest protection may be revolutionized by drone technology. They offer a bird's eye view of the forests and wildlife in addition to information, images, and data that would otherwise be challenging or prohibitively expensive to access (Dash *et al.* 2018) [7]. In order to perform surveillance, identify unauthorized settlements, and prevent poachers in Kaziranga National Park, which spans 480 square kilometers, the government of Assam, the Republic of India, has teamed with Tata Consulting Services (TCS) (Dash *et al.* 2017) [6]. Drones using thermal cameras can detect the heat signatures of poachers even when they are hidden in dense vegetation and recognize them. This work has benefited the threatened one-horned rhinoceros.

Crop insurance

Aerial imaging can be used to swiftly categorize surveyed regions into cultivated and non-cultivated land and to determine how much damage has been done by natural catastrophes. Drone imagery that is easily replicable and accessible is also advantageous to crop insurers and insurance policyholders. Insurance companies in India intend to employ UAVs to analyse crop losses during natural catastrophes, enabling them to more swiftly and precisely determine reimbursements. Based on previous yield, pest, and weather data, they can create statistical models for risk management using the same data. Drone data might be shared with farmers by insurance firms and used for the early discovery and forecasting of insect infestations. Finally, the use of drone data to identify insurance fraud can stop fraudsters from insuring the same plot of land more than once or from making false claims of damage (Ahirwar *et al*. 2019) [2].

Advantages of Drones in Agriculture

Previously, satellite or plane imaging was employed to provide a broad perspective of the farm and identify potential issues. They also lacked the level of precision that drones can provide. It offers time-based animation that can display crop development in real-time in addition to real-time imagery. Following is a list of some outstanding advantages:

- This is a solution that is outsourced and requires less labour. Consequently, there is less reliance on departmental staff.
- Quick processing is possible since the findings can be obtained in a short amount of time (approximately 3-4 weeks).
- In any weather, a drone can fly. Despite the fact that drones are water-resistant, taking pictures in a downpour can reduce the quality of the images.
- Drones can help farmers make the most of their inputs (seed, fertilizer, and water), react more swiftly to threats (weeds, pests, and fungi), shorten crop scouting times (validating treatments/actions taken), enhance variable-rate prescriptions in real-time, and calculate the yield from a field.
- Any crop in any place may be monitored with drones. It is a relatively new agricultural technology, thus in the approaching years, its market and application are anticipated to grow dramatically.
- The technique has also shown promise in providing a thorough picture of plant population and emergence, which can help with replanting decisions.
- No matter the weather, a drone can fly. Despite the fact that drones can withstand water, taking pictures in the rain can reduce the quality of the images.
- Drones can help farmers make the most of their inputs (seed, fertilizer, and water), react more swiftly to threats (weeds, pests, and fungi), shorten crop scouting times (validating treatments/actions taken), enhance variable-rate prescriptions in real-time, and calculate the yield from a field.

Limitation

The following drawbacks and/or shortcomings apply to agriculture drones.

- High initial cost
- The essential analysis of drone picture data cannot be done by a traditional farmer. You'll need a few fundamental skills and expertise in order to operate an agriculture drone. The farmer will need to develop his or her understanding and skills of picture software in these situations.
- The threat to wildlife, especially birds, is one of the many grave environmental effects that warrant concern.
- Drones fly above the ground and have the potential to crash if they lose control for any reason. Additionally, because they share airspace with commercial aircraft, they could interfere with manned aircraft if they fly in their flight path.
- Flying them is challenging in severe weather. Extreme weather, fog, and wind can all hinder the devices from recording the necessary space or allowing them to fly. Rain is capable of harming a drone's electronic parts. For image capturing, there must be a lot of sunlight. Drones are susceptible to weather variations since they are continually changing. Drones are interrupted by severe weather.
- To utilize it, you'll need to obtain a government clearance.

- The expanding list of restrictions surrounding air space could result in financial or legal fines due to the constantly evolving laws and regulations surrounding drone flight.
- One drawback of a drone survey is its short battery life. This shortens the drone's flight time.

Reasons to Use Drones in the Utilities Sector

Unmanned aircraft systems (UAS), sometimes known as drones, are being deployed throughout commercial enterprises as a more efficient way to transport goods and people.

1. Economical and effective solution

It has been difficult and expensive to survey, find, and locate leaks and remedy concerns in the past. Inspecting difficult-to-reach equipment, power and gas lines, trains, and highways can be more affordable with the aid of drones. The cost of aerial inspections might be reduced by drones by up to 50%, according to estimates.

2. Employee Safety

Drill sites, gas pipelines, landfills, and other hazardous municipal operations can all be safely mapped in 3D using UAS technologies. Drone use could increase worker safety for routine inspections in both rural and populated locations, as well as for assessing energy network damage following natural catastrophes, among other uses.

3. Effectiveness of Data Collection

In comparison to the conventional ground or air (such as helicopter) surveillance, drones allow faster data retrieval. A single drone offers a considerably speedier method of obtaining the same kind of information and images that two or three personnel would need to create over the course of several hours. Additionally, drones can digitize that data into something that operators on the ground can almost immediately assess.

4. Better Inspection Process

The use of drones for mapping, imaging, and LIDAR-a surveying method that employs laser light to determine distances-could make it easier to check difficult-to-reach locations. Due to visual line of sight and safety concerns, UAS with cameras can access places that humans previously couldn't for closer visual inspections.

5. Reliable Data

Utility companies will gain a competitive edge thanks to the creative things they do with the data they collect. Drones can fly over difficult-to-reach areas where utility personnel must navigate while sending back photographs of the state of electricity wires and pipelines to alert the ground team to critical issues. UAS are able to hover in the air for longer periods of time than typical helicopter fly-bys, which allows them to capture photographs with greater detail.

6. Reduce Environmental Impact

Applications of UAS can drastically lessen the environmental effect of specific utility operations, from long-distance delivery to wind turbine inspections. For instance, methane sensors can be used to monitor and measure methane gas leaks and lower methane emissions.

7. Increase Resource Efficiency

Utilizing resources wisely is crucial to a sustainable business. Drone services could be the answer your business is looking for to stay on schedule, make rapid, accurate judgments, or examine a critical issue.

Way Forward

We are all aware that while technology might increase security and simplicity of living, it also carries threats. Therefore, we must use it wisely. In this sense, India's Unmanned Aerial Vehicle industry enters a new era with the new drone rules. The regulations are predicated on the concepts of self-certification and trust. Entry hurdles, compliance procedures, and approvals have all been greatly decreased. The start-ups and our young people working in this industry would benefit greatly from these rules. It will create fresh opportunities for business and innovation in the agriculture sector. Making India a drone hub will be made possible by utilizing India's advantages in innovation, technology, and engineering. Indian agriculture could be dramatically changed by drones. Future technological advancements are anticipated to make drone manufacturing economically viable. Due to the arduous labor and tedium required in farming, modern adolescents are not drawn to it. Drones' potential applications could interest and inspire young people to pursue agriculture. The use of agricultural drones is unquestionably the way that the agrarian sector in India will develop in the future, as was already mentioned. Numerous ways exist where it can alter conventional farming practices. Although it takes more effort to become comfortable with this technology, once you do it will start to pay off right away. The entire procedure must be understood by farmers. It will be difficult to set objectives, balance the software and drone used, and understand the basic concepts of employing such technology. For the farmers to obtain accurate data, extensive training or collaborations with outside professionals in the drone sector will be required. In practically every type of industry, drones have altered how data is collected, and in the years to come, they're only going to get better and more prevalent.

The integration of contemporary agricultural technologies, such as the use of drones or unmanned aerial vehicles (UAVs), could transform how we anticipate and respond to disasters that threaten the livelihoods of vulnerable farmers and the nation's food security. In farming, external influences like the weather, the status of the soil, and the temperature are crucial. The farmer may make thoughtful decisions and adapt to particular environments due to agriculture drones. The information gathered is used to control crop health, crop treatment, crop scouting, irrigation, field soil analysis, and crop damage assessments. Drone surveying increases crop yields while reducing costs and time.

Conclusion

Numerous agricultural operations can be carried out effectively using drone technology. According to the Association for Unmanned Vehicle Systems International (AUVSI), more than 900 businesses would be using over 2900 unmanned aerial vehicles (UAVs) by the year 2020. Two of the most challenging challenges to overcome in order to make it popular and farmer-friendly are high initial costs and governmental modifications. Despite the drawbacks, the use of these tools and technologies in agriculture to disseminate knowledge about farming is expanding quickly. Drone technology is utilized to reduce human labor in a variety of agricultural operations, such as the identification of pest presence, the application of UREA and other fertilizers, and others. To prevent human health issues when applying pesticides manually, UAV aircraft are employed to spray the chemicals. With the ability to make decisions in days rather than weeks and the promise of major cost reductions and productivity increases, these technologies are anticipated to transform the agricultural industry. Such choices support the four pillars of precision agriculture, which include applying the correct practice at the right place, at the right time, and with the right quantity. They also enable the effective application of farm inputs that's why drone technology is an innovative technology that plays a crucial role in the agriculture sector.

Acknowledgment

We are thankful to the authors whomever we have mentioned in this review paper as their precise content made the whole process easier to collect specific information about innovative drone technology in agriculture.

Conflict of Interest

There is no conflict of interest between the authors.

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