Minireview Article

Pivotal Role of Drones in Agriculture – a Review

Abstract

Indian agriculture is currently undergoing a drastic drift towards mechanization and usage of modern day Information and Communication Technology (ICT) tools as a subsidiary to the mighty work carried over by the farmers in their respective fields to serve millions of people with food. Owing to the various efforts taken by agricultural scientists and scholars, the scope of Artificial Intelligence has also influenced agriculture and is finding solutions to the modern day problems in agriculture such as labour scarcity, less productivity and other such consequences. One important component is the use of Unmanned Aerial Vehicles (UAVs), popularly called as Drones and their applications in agriculture. Even the union as well as the state governments of India are focussing on providing drones to the farmers as a part of fostering the concept of Sustainable Agriculture. This article reviews the various spheres where the drones can be utilized and the statistics as well as the benefits using drones in agriculture.

Keywords: Unmanned Aerial Vehicles, Agriculture, Benefits, Regulations, Policies

INTRODUCTION

The sector of agriculture, although it contributes to 20.2 per cent of the Gross Domestic Product (GDP) of India (Press Information Bureau, 2021), it gambles with various constraints such as abnormal monsoons, production related issue, low productivity, labour shortage, price fluctuations, etc. Agriculture is the prime work source for man of the rural households. The FAO report on India at a Glance, 2022 in its report have insisted that 70 per cent of the rural households still depend on agriculture and about 82 per cent of the farm households are small and marginal. It is the dire need of all the stakeholders who are involved around agriculture to look into this situation seriously and find out path breaking ways to achieve sustainability for our younger generation. Automation in agriculture is an emerging subject across the world. In the current trend, the concept of Artificial Intelligence has found many applications in building solutions for agriculture related problems, which not only empower the farmers to continue farming amidst eradicating natural resources and also would improve the quality and ensure quick market penetration of various crops. Of all these, a pivotal role is being played by the technology of Unmanned Aerial Vehicles (UAVs), commonly referred to as Drones for agricultural purposes. Although it is in the latent stage and as a much longer road ahead, its presence can be felt in many patches of our country.

WHAT IS A DRONE?

Drones, which are technically referred to as 'Unmanned Aerial Vehicles (UAVs)' are useful for carrying out tasks that are sometimes considered impossible for humans to do. These were originally developed for military purposes when the first types of drones were used in First World War. But now it has found its way into mainstream because of the enhanced levels of safety and efficiency they bring. These vehicles do not need a pilot on

board and it can either be controlled manually or by relying on a system of sensors (like LIDAR detectors) (Built In, 2022). Drones in general refer to multirotors. A multirotor is fixed with three or more propellers which are used for hovering or flying in any direction. However, the most commonly used type of drone is the quadcopter having four propellers (GCF Global, 2022).

In the recent trend, drones have become essential for various tasks in different organizations and have also helped a lending hand in uplifting industries that were about to perish. From delivery services of food orders to scan an unreachable military base, drones are very smart enough than humans acting in a more effective and in an efficient way. Moving the work related graph upwards, decrease in work pressure and production costs, excellent accuracy, refining service and customer relations and solving security issues on a large scale are some of the areas where drones find a place. In addition to it, the acceptance of drone technology is gradually rising up owing to its potential being understood by businesses (Divya Joshi, 2019). It is in this aspect that having an outlook on the various literatures pertaining to the drone technology and the change it has created in the recent times, which is been carried out in this research article.

HISTORY OF DRONES

Although there is not a clear reveal on when was drones first used in agriculture, a seed was sown in such a huge step during the year 1906 when John Chaytor, a New Zealand farmer, spread grass seed in a wet valley on the family farm Marshlands in Wairau, Marlborough, using a hot air balloon controlled by ropes from the ground (Frankelius et al, 2022). The founder of this novel technology is considered to be Abe Karem for building the first fully functional drone for Israel in the year 1974, but unfortunately not meant for agricultural purposes. One evidence show that drone for agriculture was first used by Thurling in 1985 by fixing a camera on the drone for taking vertical images of weeds in an oilseed crop (Christopher Leonard, 2022). From then onwards, its spread has been phenomenal all over the developed countries. It is unknown about the fact of when drones were used first in agriculture, but the Union Ministry of Civil Aviation only in the year 2021 spelt regulations pertaining to usage of drones in the form of policy formulations and using this, the Union Ministry of Agriculture and Farmers' Welfare came up with Standard Operating Protocols (SOPs) for drone operations in agricultural lands (Economic Times, 2022).

DRONES AND THEIR PARTS

Even though drones find place in every business, many of the people do not know the proper name of a particular part of a drone. Hence it would be appropriate to introduce the different parts of a quadcopter and their function in the below table.

Table 1. Parts of a drone and its use

S.No	Name of the Part	Use
1.	Quadcopter Frame	It acts as a skeleton for placing different components to have a uniformity of the centre of gravity of the drone.
2.	Motors	Useful for the propelling the drone
3.	Electronic Speed Controller	Helps the operating pilot to adjust the height of the running drone.
4.	Flight Control / Board	Makes a log of the take-off place if at any emergency situation occurs and there is no guidance from the pilot.
5.	Propellers	Used to fy the drone. During motion, they cut the air by creating a difference in pressure between top and bottom of the rotors.

6.	Radio Transmitter	A channelled transmitter and a communicator for the drone.
7.	Battery, Electronics and Power Distribution Cables	Lithium batteries are used. These act as the power source to the drone. Other components are used only when needed.
8.	Camera	For shooting, storing and sending videos and maps to the receiver's end for data purposes.
9.	Landing gear	There are two types of landing gear – fixed and retractable landing gears. Landing gears are meant for safe landing o the drones after flying.
10.	First Person Video	It gives the user a 3D view experience to the normal control device interface i.e., transmitter

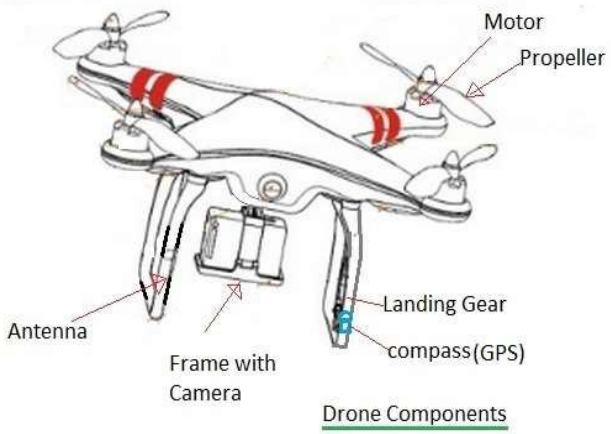

Fig. 1. Drones and their components

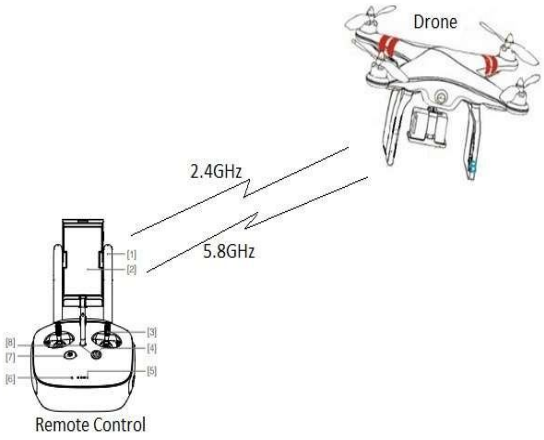

Fig. 2. Frequency to and fro from the remote control to the drones

USES OF DRONES IN AGRICULTURE

The applications of drones have influenced even the field of agriculture since it has got wide opportunities in the recently identified technology namely the Precision agriculture. They have a wide range of uses starting from soil and crop field analysis to planting and spraying pesticides. Drones can also be used with various imaging technologies such as hyper spectral, multispectral, thermal, etc. which can provide the farming community with

time and area – specific information pertaining to crop health, fungal infections, growth bottlenecks, etc. Drones are also helpful in identifying drier regions of as field and measures that can be taken for irrigating those regions. Such concrete information when provided to farmers would help them take decisions regarding resource allocation and utilization in an efficient manner (Idea Forge, 2021).

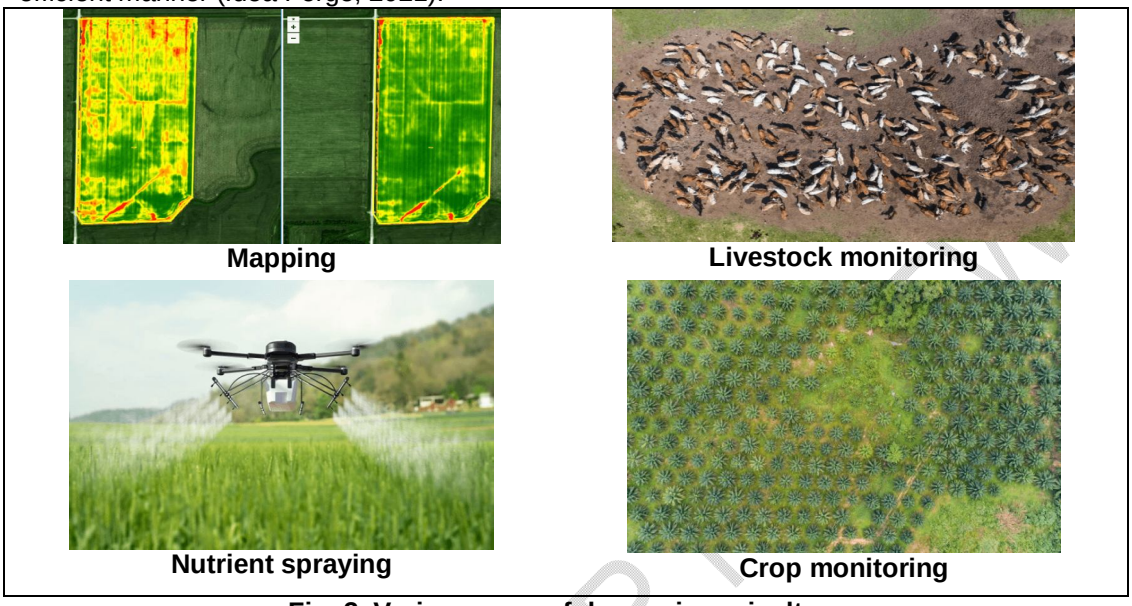

Fig. 3. Various uses of drones in agriculture

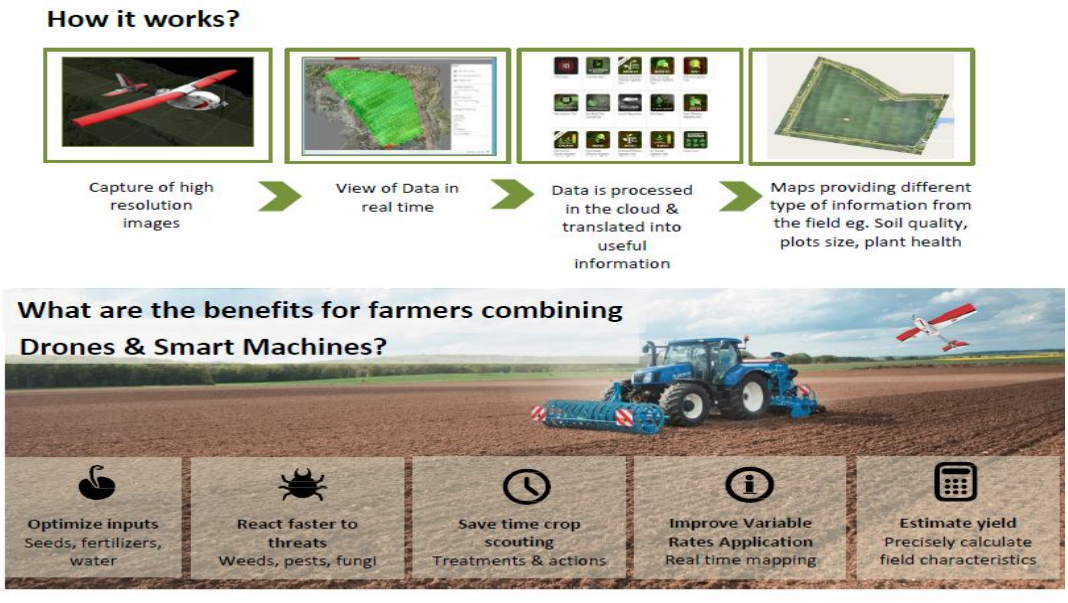

Fig. 4. Working of drones and their benefits

IDEAL CONDITIONS REQUIRED FOR FLYING A DRONE

Even though the drones can be flown at any time a day, many prefer to fly them at a time when there is a clear sky and the photography captures precisely the field conditions. Most of the times, the drones are used in the 'Golden Hour' viz., the hour before sunset or just after the sunrise. At these times, the sun gives off brilliant colours, softer shadows and great photos. Some drone pilots prefer the 'Blue Hour' that is the hour right after the sunset

of before sunrise since the stream of sunlight that appears on the sky gives stunning effects on the photography. Coming to weather conditions, the optimal conditions are without much wind in the atmosphere and with moderate temperatures. One should stay away from operating drones when there are extreme conditions such as rain, strong winds and too hot or too cold weather conditions. Also it is recommended by various experts that it is avoidable to fly a drone during winter conditions since it may slow up the battery and many at times the batteries would be non – functional (Droneblog, 2022). Hence it is essential to have an eye on the weather state before employing drones for agricultural purposes.

BENEFITS OF USING DRONES IN AGRICULTURE

Drones can act as a viable alternative for tacking various challenges prevailing in agriculture. They can be used for targeted input application, timely diagnosis of nutrient deficiency which can be used to provide nutrients at the right amount, crop health monitoring, rapid assessment of crop yield and crop losses. These can be used to cover large land areas which are difficult even for the farmers to perform various agricultural activities. Drones have the capacity to operate at low heights (1.0 to 3.0 m) over the crop canopy making it suitable for spraying nutrients and adaptable to different crops. Spraying of crop and soil nutrients using drones helps famers in saving cost, resources and time. Drones are even useful for various geographical areas such as tough terrain and hilly areas which are inaccessible (GoI, 2019).

RULES AND REGULATIONS FOR USING DRONES

In India, the Directorate General of Civil Aviation acts as the nodal agency in framing rules and regulations for usage of drones. The drones need to be registered on Digital Sky Platform. Drones are available in different designs and payloads with some of the drones having payloads ranging from 1 kg to 25 kg. For agriculture, the drones of payload capacity of 10 kg are being used since it costs less, less voluminous, low operating cost, easy to transport, less chances of instability and accidents. In addition to this, drones of this payload capacity do not require Air Traffic Control (ATC) clearance before flying. Although there are many protocols for drones spraying, the Recommended Dose of Fertilizer (RDF) based nutrient application protocol is widely used for both granular and liquid nutrients. In India currently drones are being used mostly for spraying nutrients, especially for foliar spray. Hence the adjustment of various nozzles (centrifugal, electrostatic, atomizer, etc.) can be done without any difficulty.

Drones having the payload capacity of 10 kg can cover 30 acres per day which is equivalent to 6 hours per day having the stock of five batteries. The cost of operating the drone varies for different agro climatic conditions ranging from Rs 350 to Rs. 450 per acre per operation for the time of 6 – 10 minute flight. Proper usage guidelines must be ensured when operating the drone like maintain a distance of 1.0 m – 3.0 m from the crop canopy, flying the drone at the speed between 3.0 – 6.0 m/s and the payload of the drone should not exceed more than 10 litres per flight. The rotational speed of the disc of the drones should be in the range of 800 to 1000 rpm and it may vary according to the manufacturer. Appropriate pressure of 100 - 150µm must be maintained for an optimized droplet spectrum. One who is operating the drone should wear PPE (Personal Protection Equipment) kit. For proper maintenance of drones, the owner of the drones should follow the recommendations made by Dr.Alagusundaram committee formed for enhancing the adoption of 'Krishi' drones (GoI, 2019).

POLICY FRAMEWORK FOR DRONES IN INDIA

The agricultural drone market is expected to grow from USD 1.2 billion by 2019 to USD 4.8 billion by 2024. Some of the key factors that influence the increasing need of drones in agriculture include pressure on increased food production due to growing population and an increase in venture funding for drones (Future Farming, 2019). In India, any drone operator other than a foreign operator is allowed to fly a drone and as a

compulsory measure must register in the Digital Sky platform by filling Form D-2 with the specified fee under Rule 46. The provisions of Motor Vehicles Act, 1988 (59 of 1988) shall apply for any damage caused by the unmanned aerial vehicles. The drones used should be No Permission – No Take-off (NPNT) compliant and an Unique Identification Number (UIN) is obtained from the DGCA and the number is affixed on the drones (Drone Laws, 2022). In the recently announced Union Budget of 2022 – 23, the union government has indicated that the Sub – Mission on Agricultural Mechanization (SMAM) has been amended to grant up to 100% of the cost of agricultural drone or Rs. 10 lakhs, whichever is less, by the Union Government of India. The FPOs (Farmer Producer Organizations) are eligible to receive up to 75.00 per cent grant for promoting drones among the farmers by demonstrations. A contingency expenditure of Rs.6000 per hectare would be provided to agencies that hire drones from owing agencies such as Custom Hiring Centres and those who purchase drones for demonstrations would receive a contingency of Rs. 3000 per hectare. These are available until March, 2023. To promote entrepreneurship among agriculture graduates, financial support up to 50% of the basic cost of drones or Rs. 5 lakhs whichever is less is provided to them (Press Information Bureau, 2022). In order to promote drones through start-ups and skilling at Industrial Training Institutes (ITIs), the government has insisted on promoting 'Drone Shakti' through varied applications and for Drone – as – a – Service (DrAAS) (The Hindu, 2022). Also the government will also promote 'Kisan drones' for farmers to help them assess crops, digitizing land records and as well as to modernize spraying nutrients to the crops (Down to Earth, 2022).

In order to boost the efforts of the union government in promoting Digital Agriculture, the Tamil Nadu government has decided to procure 60 drones under the SMAM scheme for conducting demonstrations on spraying fertilizers in 14,400 hectares of land, which will be implemented by Tamil Nadu Agricultural University. TNAU has been carrying out research in promoting drones in agriculture owing to the labour shortage problems being faced in agriculture. It gained a great success during the evaluation of the aftermath effects of Gaja cyclone affected districts which cost Rs.650 per care in the place of Rs. 1200 per acre when done manually (The New Indian Express, 2022).

CONCLUSION

Drone technology is definitely a game changer in the field of agriculture. Many Indian start-ups are investing more in low – cost drones that can help farmers and create simultaneously employment opportunities for the rural youth and enhance the knowledge of farmers too. However, the drone industry needs more path breaking reforms by taking into account the rapid increase in population, dire needs of the farmers, operational policies and shrinking farm fields which is a matter to be worried.

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