DRONE: THE GREEN TECHNOLOGY FOR FUTURE AGRICULTURE

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"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."

(José Luis Fernández)
FAO Representative in the Philippines

Climate change and environmental pollution are the major global issues of the current era and severely impacting agricultural productivity. Conventional agricultural practices along with other factors like deforestation, fossil fuel combustion, etc. also contribute towards amplification of global warming and related issues. Sustainable agriculture is one of the solutions to combat environmental pollution and reduction of greenhouse gas emissions, thereby offsetting the effect of climate change. In conventional agriculture systems, farmers generally apply fertilizers, pesticide, and other agrochemicals in heavy amounts indiscriminately. The higher dose of fertilizers is not utilized by crops properly, and thus unutilized fertilizers act as a source of pollution in the environment generating greenhouse gases. Therefore, there is a need for clean and green technologies to perform agricultural practices in a sustainable manner. In this context, drone or UAV comes into the picture.

DRONE (Dynamic Remotely Operated Navigation Equipment), also known as UAV, is a device which can fly either with the help of autopilot and GPS coordinates on the pre-set course or can be operated manually with radio signals using the remote control or smartphone app. With the availability of so many sensors, drones can detect the things which are beyond the visible range of human sight. Therefore, real-time, more accurate, reliable, and objective information can be derived from drones in greater detail and fewer errors.

We know that the drones have a plethora of applications in various fields ranging from military surveillance, cinematography, wedding videos, railway track monitoring, wildlife monitoring, delivery of small packages, security purposes, law enforcement operations, search and rescue operations, and disaster management. Thus, the potential of drones to become an element of the green technologies in the near future with vast utility in attaining sustainable agriculture cannot be undermined. Presently, farmers are facing many problems like unavailability or high cost of labours, health problems by coming in contact with chemicals (fertilizers, pesticides, etc.) while applying them in the field, bite by insects or animals, etc. In this context, drones can also help farmers in avoiding these troubles in conjunction with the benefits of being a green technology. Drones are nowadays emerging as a component of precision agriculture along with contributing to sustainable agriculture. Various sensors are used in the drones based upon the purpose. Mostly the sensors sensitive to the following bands of electromagnetic waves are used in agriculture:

1. Red, Green, and Blue (RGB) bands: These bands are used for counting the number of plants, for modeling elevation, and visual inspection of the crop field.
2. Near Infra-Red (NIR) band: This band is used for water management, erosion analysis, plant counting, soil moisture analysis, and assessment of crop health.

3. Red Edge band (RE): It is used for plant counting, water management, and crop health assessment.
4. Thermal Infra-Red band: This band has applicability in irrigation scheduling, analyzing plant physiology, and yield forecasting.

There are two kinds of UAVs based on their structure – Fixed wing and multirotor. Fixed wing UAVs are ideal for aerial surveys, capturing high – resolution aerial photos, mapping and land surveying whereas multirotor UAVs are best for surveillance, and detection of crop pests, diseases and weeds. Data collected by drones are better than satellite data in many aspects as drones can avoid the hindrance caused by clouds, thus, can avoid missing data while capturing images which is a common problem in acquiring data by satellites especially during monsoon season. Another advantage of a drone over satellite is that it can be operated anytime whereas the satellite passes only at the fixed pre-defined time. Hence, drones provide real-time data in greater detail and less error as compared to the satellite data. In order to avoid repetitive flying of drones in the field, the data captured by drones can be blended with the satellite data, which can increase the accuracy of satellite data. Thus, data acquired by drones can complement satellite data.

APPLICATIONS OF DRONES IN AGRICULTURE

There are various applications of drones in agriculture which are briefly discussed below:

Soil and field analysis: Drones can be used to mount sensors which are able to analyze the soil conditions, terrain conditions, moisture content, nutrients content and fertility levels of the soil which can be further used for planning the pattern of sowing of different crops, irrigation scheduling as well as for managing fertilizers application considering spatial variability of the crop growth and field conditions.

Planting crops and trees: Drones can be used for planting crops which can save labour cost and reduce human drudgery. As there would be no use of tractors for sowing crops in the field, drones can save fuels, reduce the emission of harmful gases formed during fuel exhaustion while operating tractors in the field, and can avoid the compaction of subsoil as well as formation of plough pan which generally forms due to repetitive movement of tractors on soil surface. Drones can be used to plant trees or crops in remote areas by throwing biodegradable seed pods or seed bombs (Figure 1). Thus, they can be used for the restoration of degraded lands by planting trees, and also for reforestation as well as afforestation activities.

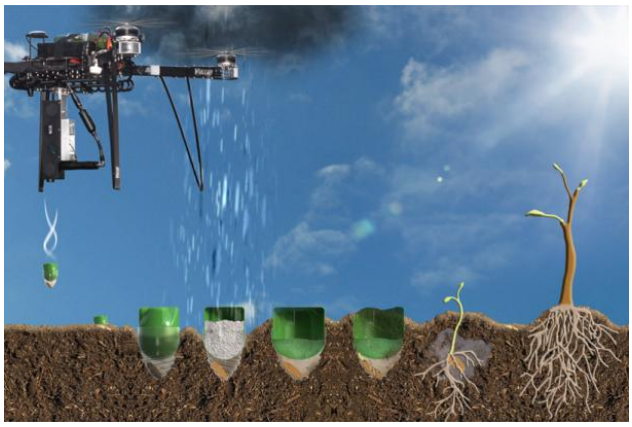

Figure 1. Seed Bombing Drone
(Source: http://www.100dronesforsale.com)

Crop monitoring: Drones can be used for monitoring the conditions of crops throughout the crop season so that the need-based and timely action can be taken. The quick and appropriate action can prevent yield loss. This technology will eliminate the need to visually inspecting the crops by the farmers. They can monitor the horticultural crops or other crops present in remote areas like mountainous regions. They can also monitor the tall crops and trees efficiently, which are otherwise challenging to scout physically by farmers.

The data acquired by drones during crop monitoring could be used to compute vegetation indices, which can be integrated with weather forecast data and soil fertility data. This could be used to precisely estimate the time of harvesting and yield of the crops. This may help farmers and bureaucrats to plan for warehouse and processing facilities, as well as for marketing in advance.

Weed identification: Drones can be used to identify the weeds present in the field. These weeds could be timely

rooted out from the field so that they do not compete for resources with the main crop.

Crop spraying: Drones can be used to spray chemicals like fertilizers, pesticides, etc. based on the spatial variability of the crops and field. The amount of chemicals to be sprayed can be adjusted depending upon the crop conditions, or the degree of severity of the insect-pest attack. In this way, drones pave the pathway to precision agriculture. This ultimately increases the efficiency of the chemicals applied, thereby reducing their adverse impacts on the environment by decreasing the soil and water pollution. Thus, it can lead towards sustainable agriculture. Drones spray chemicals at a faster rate as compared to other methods. It can also result in the saving of the amount of chemicals applied, which can reduce input cost. There is also a problem of imbalance of tractor operated machinery while spraying chemicals over tall crops which may sometimes result in accidents. So, the spraying of chemicals over tall crops can be done easily by drones without any damage.

The management of excess crop residues in the farm is the major problem faced by the Indian farmers after harvesting of the crops. Removing these crop residues from the fields is very costly and time-consuming. Therefore, farmers tend to burn these residues, resulting in environmental pollution and degradation of soil health. These residues can be efficiently and cost-effectively managed by the spraying of crop residue decomposing microbial formulations in the field. This operation can be effectively performed by the drones, which can maintain soil quality and prevent environmental pollution.

Irrigation scheduling of crops: Drones having sensors for optical, multispectral, and thermal imaging which can pinpoint the heat and water stress in the crops at a specific location. It can be used to apply irrigation to the crops based on their requirement. This will prevent the wastage of water and will ensure the efficient utilization of irrigation water.

Crop health assessment: By using different kinds of sensors pertaining to visible, NIR and thermal infrared rays, different multispectral indices can be computed based on the reflection pattern at different wavelengths. These indices can be used to assess the conditions of crops like water stress, insect-pest attack, diseases, etc. The sensors present over the drones can see the incidence of diseases or deficiency even before the appearance of visible symptoms. Thus, they serve as a tool for early detection of the diseases. In this way, drones can be used for early warning system so that timely action can be taken by applying the remedial measures based on the degree of the stress.

Geofencing or protecting the field from animal damage: The thermal cameras mounted over drones can detect animals or human beings during the night. So, it can be used to protect fields from the damage caused by animals, which are otherwise difficult to detect in the large fields during night time. So, it will work more efficiently than human guards.

Crop insurance: Drones can be used for precisely estimating and monitoring of the crop failure. So, it can be helpful for the farmers as well as for insurance companies in providing insurance claims based on the degree of damage. This technology has great potential in accurate and effective implementation of crop insurance scheme, namely *Pradhan Mantri Fasal Bima Yojana* in India without any bias.

Livestock management: Drones can be used to manage the large herd of livestock. The sensors having high-resolution infrared cameras present over drone can detect the diseased animal swiftly by their heat signatures. The detected diseased animal can then be separated from their fellow animals, and the early treatment can be provided. So, the drone could be used for precision dairy farming.

Hence, we can see that the drones can have vast applications in agricultural and livestock management, which can be beneficial for farmers, scientists, extension workers, businessmen, bureaucrats, and policy makers. The data acquired from drones can be used as inputs. It can provide actual yield data as well as estimates. It may assist in providing valuable data for analysis of weather conditions. It can also be used to develop early warning systems. In India, the drone was used to determine the area under coffee plantations in order to estimate yield in 2016. Drones are currently being used by Skymet company for providing

agriculture survey services to insurance companies and the state governments of Maharashtra, Gujarat, Rajasthan, and Madhya Pradesh.

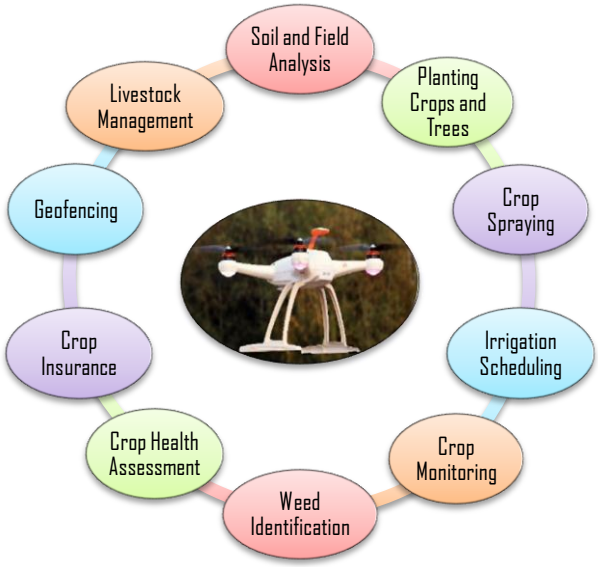

Figure 2. Applications of drones in agriculture

There are several challenges in the application of drones in Indian agriculture, which is responsible for its limited adoption. There are certain regulations by the government regarding the flying of the drones, which makes farmers skeptical about it. Most of the farmers in India are small and marginal with poor economic status. Therefore, they are not willing to spend money on any device other than the basic requirements. After the acquisition of images by the drones, there is a need to process those images in order to derive meaningful information. Therefore, skilled personnel are required for both operations of drones as well as for processing their images. As most of the Indian farmers are not well-educated, so, they are reluctant to adopt this new technology.

Currently, drones can provide financial benefits to the farmers only when operated in large farms like in contract farming and co-operative farming. This technology can be useful for small and marginal farmers if government support is established. The governmental institutional structure can be framed at the district level in each KVK of India, where the crops can be regularly monitored through the drones by the skilled personnel. The district-level crop and field data collected from the drones can be used to provide regular advisories to the corresponding farmers of that area through mobile messages or voice call regarding the required operations to be performed in a particular farm. This kind of system can benefit Indian farmers. It can help scientists to formulate district-wise climate change adaptation and mitigation strategies as well as in the effective implementation of those strategies at field level with the help of farmers. In this way, this technology can help in making climate-resilient agriculture.

Drones have great potential to transform Indian agriculture. With the advancement of technology in the future, the production of drones is expected to become economical. The modern youth are not attracted towards farming due to hard work and drudgery involved in it. The implication of drones may fascinate and encourage the youth towards agriculture. The next agricultural revolution would be data-oriented, and drones can play a major role in it. Appropriate usage of data may increase agricultural productivity without any adverse effect on the environment, along with improving the livelihoods of farmers. Therefore, drones may become part and parcel of agriculture in the future by helping farmers in managing their fields and resources in a better and sustainable way.

REFERENCES

Ahirwar, S., Swarnkar, R., Bhukya S. and Namwade, G. 2019. Application of Drone in Agriculture. *Int. J. Curr. Microbiol. App. Sci.* 8(01): 2500-2505.

Sylvester, G. (2018). E-agriculture in action: Drones for agriculture. Published by Food and Agriculture Organization of the United Nations and International Telecommunication Union, Bangkok.

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