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e-Agriculture –Drones into Action

Dr. S. Lokesh Babu[1] & Dr.N.P. Darshan[2]
[1]Department of Agricultural Extension, Dr.YSRHU
[2]Department of Agricultural Extension. Visva Bharati University, West Bengal.

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Introduction:

Global population stood ever-increasing by many folds in the last century and will further be escalating by 2030 and 2050. Such huge world population will urge for more food and water in the future. Food security vestiges as an important and priority of many nations with special importance on developing countries. The global food system is encountering an unprecedented confluence of pressures which may increase over the years by 2050. Increased food production simultaneously requires greater inputs likewise land, water or energy individually or a combination of these inputs. Thus, essential increase in food production will build up competition for land, water and energy. Could the future growth of supply of food of a country match with its increased demand for food as a result of population pressure and rising income? A number of studies attempted to answer this and projected demand for and supply of key food items in various countries and assessed gap. According to Bennett's law the proportion of the food budget spent on starchy-staple foods declines while spending on animal-based products increases as incomes grow in developing countries. This dietary change puts pressure on agricultural resources since animal-based food requires disproportionately more agricultural resources including water in production. To meet its growing demand, India needs to lift its annual food production to 333 million tonnes by 2050 against the current level of 252 million tonnes, according to a report. The food grain production in India has increased significantly over the years, but the monsoon rains and other local factors decide the output, said the Grant Thornton-FICCI report.

Now a days in the era of modern agriculture the use of ICT has ensured that with a touch of a few buttons, agriculturists can connect with the global network of farmers, agronomists, businesses, and other service providers to stay up-to-date on the latest crop cultivation practices**.** Technological progress made in monitoring, supervision, management

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and control systems have opened a new era in which many traditional agricultural practices are outdated. Their replacement with new technologies falls into the "precision farming" category, which translates into applying the agronomic variables in the right place, at the right time and with precise control over the amount of material inputs or crop production. Drone technologies, equipped with artificial intelligence (AI), machine learning (ML), and remote sensing features, are rising in demand because of its advantages. The central government has recognized the importance of unmanned aerial vehicles (UAVs), machine learning, and artificial intelligence with their 'Digital Sky Platform' online. Drone startups in India have used this opportunity to accomplish better technological capacities. Now a day's drones have formed into a separate frontier where drone technology and advanced image data analytics with the capabilities have the potential to become important parts of the technology mix that possibly will fill the gap between current agricultural production and the needs of the future.

Basic Concept of Drone Technology:

A Drone (Dynamic Remotely Operated Navigation Equipment), commonly known as Unmanned Aerial Vehicle (UAV) is essentially flying ROBOT (The air vehicles that do not carry a human operator). The aircraft can be remotely controlled or can fly autonomously through software-controlled flight plans in their embedded system working in conjunction with onboard SENSORS and Global Positioning System (GPS). 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.

Types of Drones

1. Fixed wing drones: Fixed wing drones consist of a rigid wing (Non movable wing), fuselage (main body of the aircraft) and tails which use a motor and propeller as their propulsion system. They have the advantage of being able to fly at higher speeds for longer duration and that can cover wide range of possible environments (ex: jungle, desert, mountain, maritime etc.). But these drones have the disadvantage of requiring runway or launcher for take-off and landing and not being able to hover

2. Rotary wing drones: These drones will have the rotary blades or propeller- based systems they are called rotatory wing drones. Unlike the fixed wing models these drones can

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fly in every direction, horizontally, vertically, and also have the ability to hover and have a high maneuverability. These characters make them perfect drones for surveying hard to reach areas (pipelines, bridges). They are similar to helicopters generate lift from the constant rotation of the rotor blades. But these too have disadvantage of low speed and short flight range

3. **LTA & tethered systems drones:** Rarely used in agriculture and these have management troublesome

Fixed wing drone

Drone tethered with a wire

Rotary wing drone

Lighter-than-air (LTA) drone

Classification of Drones:

S.No	Type of Drone	Description
1	Very small drones	1. Common size range varying from a large sized insect to a 50 cm long unit. 2. Common designs in this category are: Mini Drones

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		and Nano / Micro Drones. 3. widely used due to their tiny structure and light weight construction 4. Commonly used for spying and biological welfare
2	Mini drones or small drones	1. will go above 50 cm but will have maximum 2m dimension 2. Based on the fixed wing model, whereas few can have rotary wings. 3. Due to their small size they lack in power
3	Medium drones	1. Too heavy to be carried by one person but are smaller than the light aircrafts. 2. can carry weight up to 200Kgs and have average flying capacity of 5 to 10 minutes
4	Large drones	1. Comparable to size of aircraft and are most commonly used for military applications. 2. Places that cannot be covered with normal jets are usually captured with these drones.

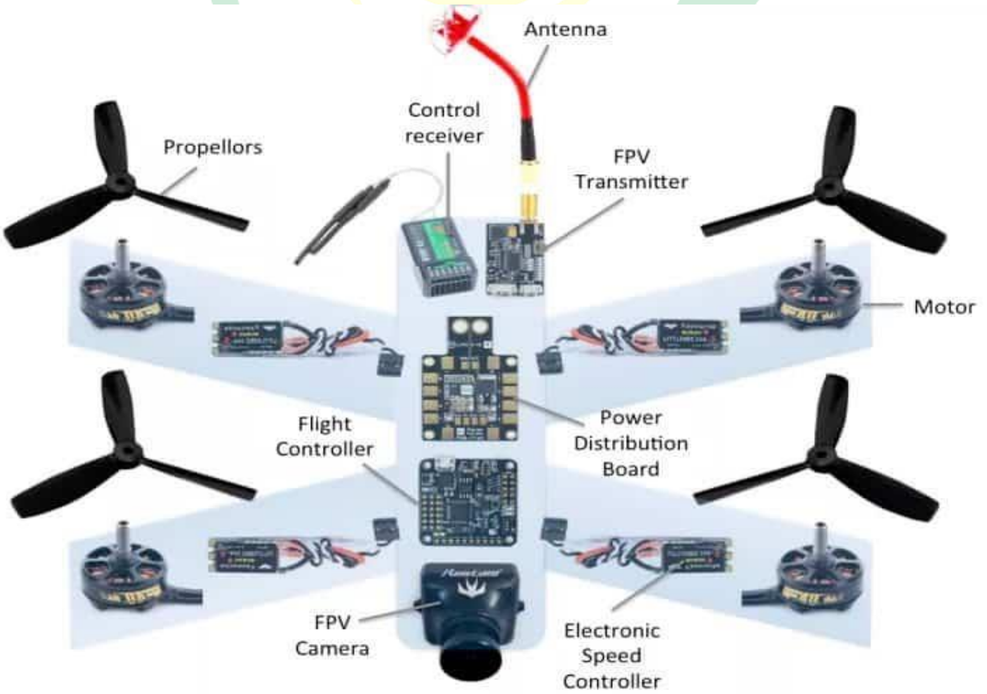

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Figure -02 Components of a Drone

Different Types of View Provided to the Farmer Through a Drone:

1) Birds' eye view: Drones are capable of seeing a crop from a bird's eye view. This particular view can reveal many issues such as irrigation problems, soil variation, and of course, pest and fungal infestations in the field.

2) Multispectral images: These images are used to show an infrared view as well as a visual spectrum view. When these views are combined, the farmer is able to see the differences between healthy and unhealthy plants. This difference is not always clearly visible to the naked eye, so having the ability to see the crops from these views can assist the farmer with assessing crop growth, as well as crop production.

3) Multitemporal analysis: Drone can survey the crops for the farmer periodically to their liking. From a choice of weekly, daily, or to each hour, the farmer is able to use this information to show the changes in the crops over time, thus showing where there might be some "trouble spots". This proves to be a key benefit because by identifying these trouble spots, the farmer can then attempt to improve crop management and improve the overall production of their crop.

Operation Of Drone in an Agricultural Field:

At first we have to mark the field in which drone should operate on our PC or mobile or tablet. Then drones will start its work in the field and capture the images of the target areas with the help of Multispectral camera sensors. The images obtained are to be analysed using software in order to get the precise information.

Applications of Drones in Agriculture:

Drones are transforming how agriculture and farming are done. By implementing drone technology, farms and agriculture businesses can improve crop yields, save time, and make land management decisions that'll improve long-term success. Now let us throw some light regarding applications of drone technology in Agriculture.

1. Soil and field analysis: They can be used to produce accurate 3-D maps that can be used for early soil analysis on soil property, moisture content, and soil erosion. This is very important in planning seed planting patterns. Even after planting, drone-driven soil analysis provides data for irrigation and nitrogen-level management in the soil.

2. Planting: Though not quite prevalent just yet, some manufactures have come up with systems able to shoot pods with seeds and plant nutrients into the already prepared soil. These drone-planting systems will decrease planting costs by 85 percent.

3. Crop spraying: Distance-measuring equipments like ultrasonic echoing and lasers drones can adjust altitude with a change in topography and geography. Their ability to scan and modulate its distance from the ground enables them to spray the correct amount of the desired liquid evenly in real time. This results in increased efficiency with a reduction in amount of chemicals penetrating into groundwater. In fact experts estimate that spraying using drones will be proven 5 times faster than the traditional methods.

4. Crop monitoring: One of the largest obstacles in farming is inefficient crop monitoring of vast fields. Monitoring challenges are made worse by the rise of unpredictable weather patterns which leads to increased risk and maintenance cost. Previously, satellite imagery offered the most advanced form of monitoring. But there were drawbacks. Today drones equipped with surveillance technology, creating time series animations that can show the precise development of a crop and reveal production inefficiencies, enabling better crop management.

5. Irrigation: Drones with hyper spectral, multispectral, or thermal sensors can identify which parts of a field are dry so water resources can be allocated much more economically i.e. more water for the dry areas and less for the wetter once. Additionally, once the crop is growing, drones allow the calculation of the vegetation index, which describes the relative density and health of the crop, and show the heat signature, the amount of energy or heat the crop emits.

6. Health assessment: It’s essential to assess crop health and spot bacterial or fungal infections on trees. By scanning a crop using both visible and near-infrared light, drone carried devices can identify which plants reflect different amounts of green light and NIR light. This information can produce multispectral images that track changes in plants and indicate their health. A speedy response can save an entire orchard. In addition, as soon as a sickness is discovered, farmers can apply and monitor remedies more precisely.

7. Mid-field weed identification: Using NDVI sensor data and post flight image data we can create weed maps that will help the farmers in easily differentiate the high weed intensity areas from healthy crop areas which are growing alongside them.

8. Cattle herd monitoring: Drones with thermal sensors are the solid option for monitoring herds from overhead they see whether animals are missing, injured or birthing. Thus drones give livestock farmers a new way to keep an eye on their livestock at all the times resulting greater profits.

9. Crop insurance: Aerial imagery can be used to quickly classify surveyed areas into cultivated and non-cultivated land, and to assess how much damage has been caused by natural disasters. Crop insurers and insurance policy holders also benefit from readily-available and easily repeatable drone imagery. In India, insurers are planning to use UAVs to conduct assessment of crop losses after natural disasters, allowing them to more accurately and quickly calculate payouts. Drone data might also be useful for the early detection and prediction of pest infestations, data that insurance companies could share with farmers. Finally, drone data can be used to detect insurance fraud, preventing fraudsters from insuring the same piece of land multiple times, or claiming damage where there is none.

10. Drone Pollination: This is just one of the latest applications of drones in agriculture still under experimentation and development. It is an exciting prospect that uses a minute drone to pollinate plants. Researchers in countries like Japan and the Netherlands are leading the charge to produce a small drone that can pollinate crops without causing damage to the plants.


a. Planting Drone


b. Irrigation Drone


c. Soil Analysis Drone


d. Crop Monitoring Drone


e. Crop Spraying Drone


f. Health Assessment Drones

LIMITATIONS:

1. Weather dependencies: weather is constantly changing and drones are vulnerable to these conditions. Severe weather interrupts drones likewise Wind speed cause turbulence, Very low and very high temperatures affect the sensors and Precipitation-heavy rain intercepts radio signals.

2. Flight time and flight range: Most of the drones have a short flight time of between 20 minutes to an hour. This makes limits the acreage that it can cover for every charge. The flight range also limits the radius that can be cover during every flight time. Drones that can offer longer flight time and longer range are relatively costlier.

3. Initial cost of purchase: Mostly, agricultural drones used for surveying have fixed wings and may cost up to $25000 (Precision Hawk's Lancaster) based on features and sensors necessary for executing its intended use. Some drones are costlier as it includes cost of imaging sensors, software, hardware and tools. The initial cost is also proportional to the payload and flight duration capacities, apart from sensors and features included.

4. Federal laws: The use of drones for agriculture purposes is considered commercial. This means the farmer needs to undergo FAA operator training so as to acquire a remote pilot certificate or hire an operator with such qualifications. FAA also demands that drones be flown at an altitude of not more than 400 feet.

5. Interference within the airspace: Agricultural drones share the same airspace with manually manned aircraft. Hence they are prone to interference. It"s, therefore, advisable the farmer files his/her flight plan with the local airport or the FAA before the flight.

6. Connectivity: Most of the arable farmlands have very little online coverage if any. This means that any farmer intending to use drones has to invest in connectivity or buy a drone capable of capturing and storing data locally in a format that can later be processed.

7. Knowledge and skill: The images require analysis by skilled and knowledgeable personnel for them to translate to any useful information. This means an average farmer without these skills may need training or may be forced to hire skilled personnel conversant with the analysis software to help out with the image processing.

8. Personal privacy encroachment fears: Farmers fear that their personal privacy is jeopardized when they start using Drones. They believe Drones expose their lands to the general public space. The primary reason is the Drones" link to the internet. When people see Drones above the bottom, they presume they are watched. Other individuals document issues when they see Drones because they feel threatened. Even if the FAA mandates guidelines to modify every resident's privacy, there are still violators that continue to invade other's personal space. Drone technology keeps improving every day. With many manufacturers entering the industry, it's hoped that the cost of the drones and the accompanying equipment will reduce. Limitations like flight time and range are also expected to be solved by an improvement in technology. These improvements will ensure that farmers reap more from the use of drones.

Wrapping Up:

Over the past decade there has been a growing number of examples of applications of drones in farming. However, there are still some crucial limitations related to drones including high initial costs, sensor capability, strict aviation regulations and lack of interest from the farmers may impede adoption of drones. Hence it is clear that the application of drones in farming is still in its early stage and maybe there is a considerable amount of room for further development concerned to both the technology and the various applications. Providentially, it is expected that with the development of drone technology, improved image processing techniques, lower costs and may allow drones to hover like tractors in future farms. To summarize, drones help farmers optimize the use of inputs such as seeds, fertilizers, water, and pesticides more efficiently. This allows timely protection of crops from pests, saves time for crop scouting, reduces overall cost in farm production, and secures high yield and quality crops. Looking further into the future, drone technology is going to change the agriculture sector. Many Indian startups are also showing interest in the industry and aiming to invest in low-cost drones, which can help farmers and simultaneously create employment opportunities for the rural youth and enhance the knowledge of farmers as well. However, the industry needs mature reforms, keeping in mind the growing population, the needs of the farmers, operational policies, and the shrinking farmlands. Moreover, trained pilots are needed to take forward the still untapped drone market. Our farmers and drone operators are the harbingers of change. Overall, it would be interesting to see how things go ahead, and how useful the applications of drones turn out to be in the long run.

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