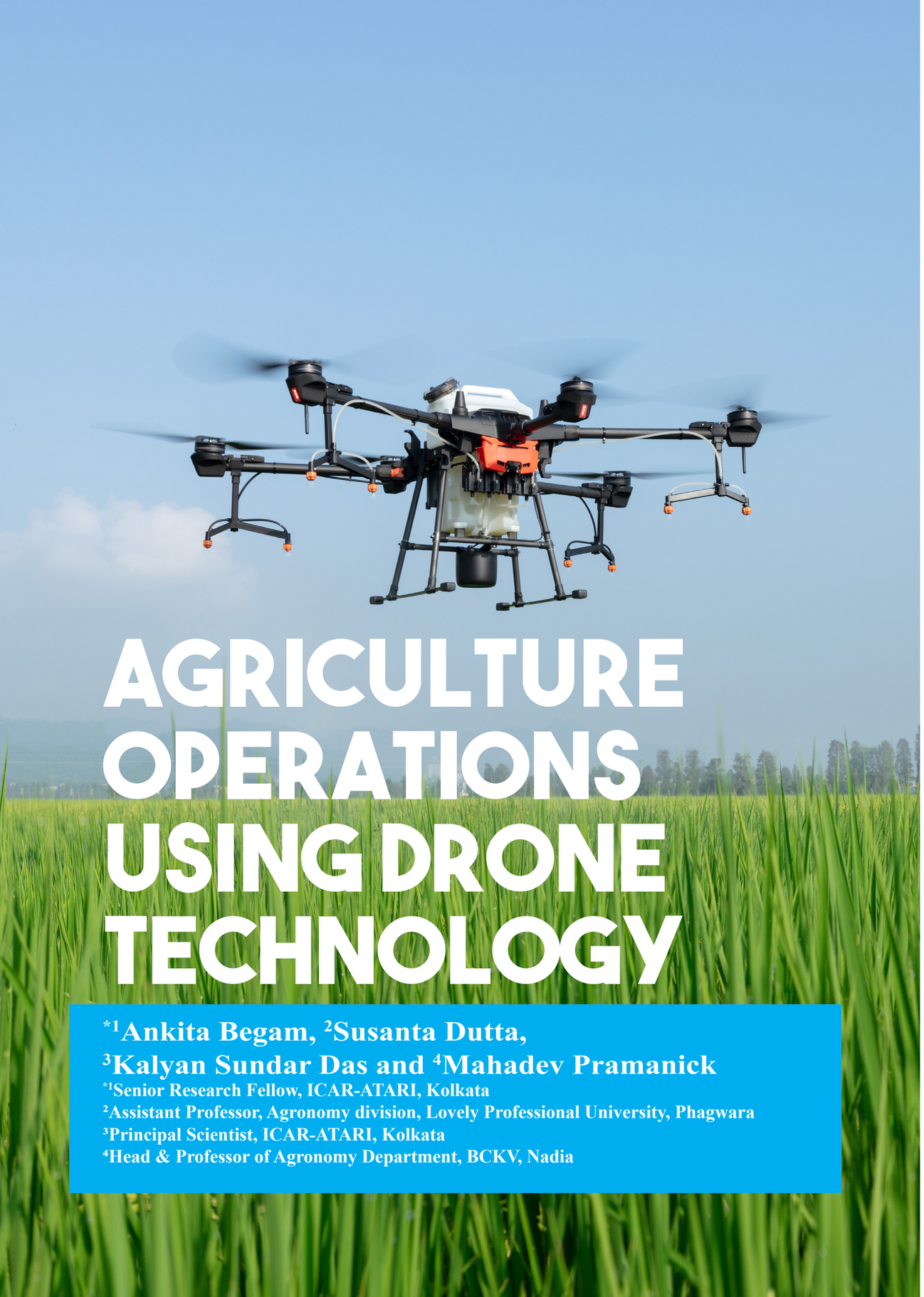

AGRICULTURE OPERATIONS USING DRONE TECHNOLOGY

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INTRODUCTION

Agriculture and its allied sectors make up the majority of livelihood in India. Seventy percent of its rural families still depend primarily on agriculture for livelihood, with small and marginal farmers making up eighty two percent of the farming population. Greater difficulties have been experienced by farming communities in meeting the needs of a large population in terms of food. Simultaneously, several global issues include climate change, soil quality deterioration, weed and pest infestation, population expansion, urbanization and worsening environmental conditions, which lead to decline in crop productivity. In order to address the issue, farmers can choose precision farming as a management strategy to ensure the efficacy of inputs like water and fertilizer and boost productivity, quality and yield.

Unmanned aerial vehicles (UAVs), or drones, are examples of advanced technologies that may be used to address problems quickly and scientifically. The incredible advancement of drone technology has the potential to transform the traditional manual activities practiced in agriculture. Drones are remotely piloted aircraft systems (RPAS), capable of carrying cameras, spraying systems, etc. to execute a specific task. They have a programmable controller with or without a satellite navigation system, automated flight planning features and they can fly in the air autonomously. An agriculture drone refers to a drone that is utilized for agricultural purposes. Agriculture drones are created to contain sensors that can transmit real-time data about the condition of crops or the movement of livestock, enabling efficient and precise control of agricultural activities. However, farmers can easily schedule their agricultural operations through out the year regarding crop and livestock husbandry using drone monitoring. In addition to these, drones can carry out a number of beneficial tasks in agriculture, such as crop monitoring, crop health assessment (under stress or not), understanding soil condition, and crop yield prediction by analyzing high-resolution images taken using NDVI (Normalized Difference Vegetation Index) imaging technology. Using analyzed insights from data gathered by drones and satellite-based remote sensing, recommendations can be taken during crop stress conditions to prevent losses from biotic and abiotic stresses by optimizing fertilization, rationalizing irrigation, reducing the impact of climate change and unpredictable weather. Additionally, the extreme COVID-19 pandemic labor scarcity in agriculture has created various chances for the usage of drones in agriculture by forcing the implementation of physical distance-keeping measures. This article discusses the current state of all the important concerns affecting the agricultural scenario.

AGRI-TECH APPLICATIONS FOR DRONES

Drones can carry out all tasks more efficiently and uniformly, resulting in decreased input waste and an increase in input use efficiency. However, drones can reduce the operational costs and closely adhere to the concept of "highest productivity with least expense". It is recommended to use drones for agricultural practices with intelligent missions to achieve the main objective, such as maximum production.

Soil testing or fertility evaluation

Assessment of soil health like physical, chemical and biological properties has prime importance for achieving the potential crop yield. The application of manures, fertilizers and soil conditioners has been proven to be an inappropriate practice without examining the soil fertility. Therefore, uniform soil sampling from the whole field is the basic step for soil

analysis; otherwise, the wrong fertility status is analyzed. This kind of practice can also be done by drones easily. In other words, it is recommended to use drones for such activities where manual operation is not possible. Hence, fertilizer requirements are optimized as per the crop needs and also fulfill the requirement for achieving the targeted crop yield. However, soil testing or fertility evaluation with the assistance of drones can increase the fertilizer use efficiency (FUE) and minimize the losses.

Crop monitoring

Crop monitoring is the most difficult task for everyone who is associated with crop production. Periodically visiting the crop field and critical observation are sophisticated actions also. Therefore, it is advantageous if drones do this action properly and uniformly where manual practice is quite difficult. Drones have many uses in agriculture, including monitoring the factors listed below.

i. Crop health: Insect damage, nutrient deficiency and color changes caused by pest infestation;

ii. Vegetation attributes: Leaf area index, crop phenology, plant density and crop yield prediction;

iii. Water needs: Weather abnormalities and uneven distribution of rainfall creates challenging environments like prolonged dry spells and excessive moisture conditions. Hence, it is advisable to frequently monitor the crop field using drones and forecast the requirement as per the crop needs. However, artificial intelligence combined with drone technology enables the irrigation to the crop field when the plant is in stressed condition.

iv. Soil investigation: Soil fertility status estimation or soil security is the great challenge for producing something on it. For this cause it is recommended to provide the nutrition to the crop required exactly. Hence, soil test crop response (STCR) is quite popular for nutrient management. This scientific approach is possible through drone visualization which also provide the balanced nutrition to the crop.

v. Afforestation: There is a scope of drone for afforestation in hilly areas because man can't do the planting of saplings. There is a chance of increasing the planting cost and simultaneously the emergence rate will be reduced in manual operations.

Agricultural spraying procedures

The health of the crop is basically depending on the application of herbicides to eradicate pests and undesirable plants like weeds. Drones can transport suitable-sized tanks that can be loaded with fertilizers, insecticides, herbicides, plant growth regulators (PGRs), etc. for faster spraying. Because of the crop's height, manual spraying operations might be challenging at times. Therefore, smart farms use drones to spray, reducing the likelihood that people will come into touch with fertilizers, pesticides and other toxic chemicals. Spraying takes less than 40 minutes to complete on a 1 ha field that is up to five times faster than conventional technology. It reduces pesticide use by 30%. Drones having sensors that can scan crops in visible and near-infrared light can be used to check crop health over time and monitor the effectiveness of corrective treatments. This can be configured to identify specifics like NDVI, water stress, or a lack of a certain nutrient in crops. In addition to helping farmers better understand how to boost agricultural yields while preventing crop damage, data from advanced sensors can be submitted to government agencies or farmers in the form of estimates or crop insurance as proof.

Followed steps for using agricultural drones

a) Analyzing the area:

This identifies the area that is being assessed. Drawing a perimeter, evaluating the topography, and finally entering the technical GPS data into the drone's navigation system constitute the initial steps.

b) Using Autonomous Drones:

Unmanned aerial vehicles (UAVs) are self-sufficient and employ pre-planned flight paths to gather the required data.

c) Uploading the data:

To collect all the required data, sensors like multispectral and RGB sensors are utilised. For further analysis and interpretation, the data is subsequently processed utilizing a number of software tools.

d) Output:

In order to move farmers closer to precision farming, they organize the data once it has been collected in a way that makes it easy for them to analyze. When using 3D mapping, also known as photogrammetry, large amounts of data are usually exhibited.

BENEFITS

- **Safety:** Drone pilots with training operate the agricultural sprayer drones remotely. Through this method, farmers or farm workers are never directly exposed to dangerous substances or unsafe working conditions.
- **High efficiency:** Several spraying operations are efficiently done by drone technique which is also comparable with traditional knapsack sprayer. For example, the drone can spray 50 to 100 acres each day, which is 30 times more than the conventional knapsack sprayer.
- **Reduction of losses:** During the manual spray, most amount is lost. To correct this wastage, it is recommended to use drones for this purpose. Because spraying through drones has minimized the losses and saved the maximum portion of liquid (upto 30%). However, drones can spray uniformly and precisely over the crops, simultaneously minimizing the drift hazard also.
- **Water saving:** Drones save a significant quantity of water (over 90%) compared to traditional spraying methods by using ultra-low volume spraying technology.
- **Minimum cost:** The cost investment required for manual spraying in the crop field is maximum. This operation is executed by using drone technology to reduce or save the cost of operations.
- **Easy to handle:** Although the handling of drones for agricultural purposes is quite sophisticated by its nature of use. It requires less maintenance, has a long useful life, and its parts are easy to replace as needed for the business providing drone services.

CONSTRAINTS

Though the smart, sophisticated drone technology makes all these things easier, like fertilizer application, spraying of weedicides and pesticides as well as planting of forest seedlings in hilly or large scale areas but also the widespread use of this technology may encounter certain limitations.

- The high cost of drones, a lack of technical expertise and lack of technically skilled workers are specifically impeding the growth of the drone industry in India.
- Drone usage in agriculture is constrained by climatic and meteorological disturbances, particularly strong winds.
- The majority of marginal farmers do not have the means to use drones in agriculture due to their poor financial conditions.
- Due to the fragmented nature of the majority of India's agricultural land, the use of drones may be severely limited.
- Prior to the use of drones in agriculture, it is crucial to calibrate the equipment correctly and do the appropriate programming to avoid making mistakes that cannot be restored.
- From an infrastructure standpoint, it was discovered that there were limitations due to a lack of custom hiring facilities, government subsidies, policies, and regulations for using drones in agriculture.

POLICY NEEDED FOR IMPLEMENTATION

Achieving a symbiotic combination of law, tax, and civil freedoms is necessary for the success of drone use in agriculture. The following legislative changes would promote drone use in agriculture.

- It is important to support drone service providers by giving them preference when registering and receiving regulatory training.
- Young entrepreneurs should be able to easily obtain and afford training for drone operators for agricultural purposes.
- Establishing BIS guidelines for testing and evaluating drones for their definite use in agriculture, as well as benchmarking drone specifications for such usage.
- Providing Farm Machinery Testing Centers with resources for testing and assessing drone applications in agriculture for accordance with BIS formulation criteria.

CONCLUSIONS

Drone technology offers a lot of potential for efficiently performing a variety of agricultural tasks. In the era of COVID-19 and the national lockdown, it can save labor while achieving social distance norms. But making it well-liked and farmer-friendly is difficult because of its high initial cost and the need for regulatory changes. Additionally, research is required to calibrate and validate drone use as well as to optimize operation methods. For the proper application of drone technology in agriculture, there are a number of other concerns that require additional study and adjustment.