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Can Drones Reduce Plant Protection Costs in Agriculture? – An Experience Based Analysis

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Abstract

The usage of drones for carrying out various need based operations in Agriculture has been increasing across several nations in the world including India. Changes in farm sector are needed to curtail the problem of green house gas emissions and mitigate ill effects of global climate change, thus, safeguard the environment. Drones are found to manage the resources on agricultural farms very efficiently. This uncrewed air vehicle technology can help reduce plant protection cost, save labour and time and improve farm efficiency. However, India is at infancy stage and yet to reap full benefits. Capacity building is required for drone operators in agriculture in order to upscale and outscale the technology. There is a need for promoting young entrepreneurs in drone technology through subsidies in order to provide employment as well as take the technology forward at a faster rate.

1. Introduction

Performing various agricultural operations like seeding, application of pesticides and nutrients, monitor crop growth, mapping, loading and uploading from and to farm fields in order to reduce drudgery, improve human and farm efficiency, reduce production costs and enhance crop productivity is known as 'Drone farming'. The drones are also called as '*unmanned air vehicles*'. Though drones are widely used for different operations, they are popular for spraying pesticides in Agriculture. They are one of the most important technologies emerged out of fourth industrial revolution. They are widely used in precision agriculture (Pinter et al., 2003; Primicerio et al., 2012) especially for precision pest management (Filho et al., 2020). The global Agricultural drone market is expected to grow at 35.9% CAGR (cumulative annual growth rate) and reach $5.7 billion by 2025. In India, more than 150 startup companies are

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already working and the drone industry worth of USD 885 million, is expected to generate thousands of jobs (Luthra, 2020). In this paper, an experience based analysis was done with regard to drone based plant protection in an adopted village in Telangana.

2. About Adopted Village Ibrahimpur

The Ibrahimpur village falls under Narayanaraopet mandal in Siddipet district, Telangana state, India was adopted by Agricultural Research Station (ARS), Professor Jayashankar Telangana State Agricultural University, Tornala, Telangana since October 2018. It is basically an agrarian village with a geographical area of 342 ha including 306 ha land under cultivation. Light textured soils are dominant accounting for 65% of cropped area. Though only 40% of the cultivated area (122 ha) was under various sources of irrigation in the yesteryears, the irrigated area increased to 240 ha (74%) during 2021 due to recharge of borewells following filling of irrigation tanks with water from lift irrigation projects and also incessant and heavy rainfall during 2020 and 2021. Hence, there exists heavy competition for labour for various operations including plant protection. At present, most of the farmers are using battery operated sprayers and to some extent motorized power sprayers for spraying plant protection chemicals. The village is facing acute labour shortage which led to high hiring cost depending on the activity (Rs. 350-500 man day^{-1}).

Ibrahimpur village, Siddipet district

3. Problems with Conventional Spraying in the Village

➢ Farmers with backpack sprayers carrying heavy spray fluids are spending hours together navigating rice and other crop fields in hot climate in order to control pest, disease and nutrient disorders, has become a labour intensive task

Drone aided aerial view of Ibrahimpur village, Siddipet district

➢ The young educated countrymen in the village are less interested in performing various Agricultural operations including spraying as they are engaged in other allied enterprises and non-agricultural schemes

➢ High cost of spraying

➢ Lack of availability of labour at right time and increasing cost of labour due to ever increasing literacy, urbanization, migration of labour from villages to towns and cities and implementation of employment guarantee scheme

Hence, there was a search for modern and efficient methods of plant protection. The scientists of ARS, Tornala found drone as the fastest means of spraying plant protection chemicals and overcome labour shortage. Further, it is also a way to showcase a new technology to the village farmers.

4. Experience in Adopted Village

The Agricultural Research Station (ARS), Professor Jayashankar Telangana State Agricultural University, Tornala, Telangana state, India has co-ordinated for spraying fungicides in rice fields on 08-10-2021 in its adopted village Ibrahimpur, Siddipet district, Telangana, as detailed below in Table 1. The fungicides *viz*., Propiconazole @ 1.0 ml lit^{-1} in 9.6 ha was sprayed against sheath rot (*Acrocylindrium oryzae*), sheath blight (*Rhizoctonia solani*) and false smut (*Ustilagonoidea virens*) diseases and Tricyclazole @ 1.0 g l^{-1} in 2.4 ha against blast disease (*Pyricularia oryzae*), totalling 12 ha covering eight farmers in rice seed production (JGL-24423 and KNM-118 varieties) and commercial production (Telangana sona and IR-64 varieties) fields. Two drones from Marut drones' tech pvt. Ltd., Hyderabad were employed. They were operated with Teejet-11002 model (cone jet) nozzle and 1.8 lit minute^{-1} discharge and at a speed of 2.7 m second^{-1}. It took 50 minutes to spray in one ha area including landing, loading and taking off.

Table 1: List of farmers' fields selected for "Pesticide spraying with Drone" at Ibrahimpur, an adopted village of ARS, Tornala

Sl. No.	Farmer's name	Crop	Crop/Variety	Area (ha)	Remarks
1	K. Nagesh Reddy	Rice	JGL-24423	2.8	Seed production
2	K. Mahender Reddy	Rice	KNM-118	2.4	Seed production
3	K. Devaiah	Rice	JGL-24423	0.8	Seed production
4	B. Kishtaiah	Rice	KNM-118	1.6	Seed production
5	A. Devaiah	Rice	KNM-118	1.6	Seed production
6	D. Parushuram	Rice	IR-64	1.2	Commercial
7	B. Ramulu	Rice	RNR-15048	0.8	Commercial
8	A. Raju	Rice	IR-64	0.8	Commercial
			Total	12.0	

Officials and Drone team

Drone for spraying in rice in Ibrahimpur village

5. Feed Back from Beneficiary Farmers

Infact, the farmers were thrilled after witnessing the completion of task (spraying) with in a short time. As it is the first time that the drone was used in the entire district in general and village in particular, many farmers enthusiastically visited the sites and enquired about the use and advantages of using drones. Many of them evinced interest and expressed readiness to employ drones on their own from ensuing season onwards. They expressed that drone is saving time, labour cost and drudgery of carrying sprayers and walking across muddy fields and contamination with toxic chemicals. The saved time could be utilized for carrying out other allied activities. The benefits expressed by the villages are detailed below.

➢ ***Less cost:*** Though cost of spraying with drone varied from Rs. 1000-1250 ha^{-1} against Rs. 1125 ha^{-1} with manual conventional spraying, but, drone saved time, reduced risk and drudgery

➢ ***Labour:*** Only the farmer can manage mixing of chemical and water in case of drone spraying, while, two labour are required for spraying in manual spraying method

➢ ***Less time*****:** 50 minutes ha^{-1} with drone against 7.5 hours ha^{-1} with battery sprayer and 4.25 hours ha^{-1} with power sprayer

➢ ***Less water:*** Only 20 litres water for drone spraying against 200 litres water per acre is required in manual spraying. So, drone spraying is a boon for water scarce areas in rainfed Agriculture as it is saving 90% water

➢ ***Less risk:*** No need for movement of labour across the crop (s) area. Drone can be operated from the crop field bunds. No problem of fatigue for the operator. Drone can reach inaccessible areas which is not possible with manual labour

➢ ***Uniform spray:*** Uniform spray is possible with proper operation of the drone by standing or sitting at a particular place in the field

➢ ***Drift problem:*** Drift problem is meager as drones help in spraying plant protection chemicals by applying some pressure while on running at 1.0 meter above over crop height

6. Advantages of Plant Protection through Drones

➢ Possibility to quickly reach the targeted place in a

short time

➢ Very easy to complete spraying chemicals in all geographical areas in general and hilly and slopy areas in particular

➢ No problem of soil compaction or crumpling of crop plants

➢ Most useful for spraying over a larger cropped area

➢ No labour exposure to harmful pesticides as there will be less contact during spray except while mixing the chemical in liquid and filling the spray tank. Thus, the risk of poisoning operators (farmers/labour) with pesticides is meager

➢ Proper and uniform application and spread of chemicals is possible as the stream of air from the drone rotors causes penetration of chemical drops into the crop canopy

➢ Drift problems are less

➢ Nearly 30% pesticide is saved mainly due to high degree of atomization. Usage of drones helped to reduce herbicide use by 52% in soybean crop during 2018-19 in Germany. Hence, the drone based spraying has gained popularity and momentum across the word due to faster and safer application of pesticides and nutrient solutions in comparison with conventional spraying methods

➢ Drone led spraying requires less water (10%) thus reduces the total spray volume vis-a-vis human led spraying

➢ Field efficiency is 20 times higher than conventional manual spraying

➢ Conservation of fuel is possible by replacing diesel with an electric power in drone. Though it is possible with conventional sprayers also, but, per unit area power consumption is less with drones

➢ At times when cost of inputs including chemicals is increasing and there is no chance and control to reduce their prices, reducing the plant protection cost through drones is the need of the hour

➢ These unmanned air vehicles are the best means of controlling the pest during outbreaks (Filho et al., 2020). For eg. locust (*Schistocerca gregaria*) attack on various crops and fall army worm (*Spodoptera frugiperda*) in corn. India has become the first country in the world to use Drone operations for anti-locust operations.

➢ The drone can cover 8-10 ha in a day depending on it's capacity and is 10 times more than the traditional knapsack sprayer

➢ Spraying can be done irrespective of crop stage which otherwise difficult with conventional sprayers. For eg. in a fully grown corn crop infested with fall army worm (*Spodoptera frugiperda*) and pigeonpea with lepidoperan larvae

➢ Drones are highly useful for spraying immediately after cessation of heavy rains too which otherwise it will be a herculian task for manual spraying in a muddy and slushy fields

➢ The agricultural drone are made rugged so they have low maintenance cost and a long lifespan. However, drones with the features of an automatic filling tank designed to match respective size of the spray areas, maintaining a constant distance above fields, flying and landing automatically and detecting and avoiding obstacles during mid-flight are preferred

7. Constraints

The drone technology has multiple problems as detailed below in Table 2.

Table 2: Problems/Constraints with drone aided plant protection and possible solutions

Sl. No.	Problem/constraint	Solution
1.	High cost of drone and accessories (Debangshi, 2021)	Drones and their accessories/parts have to be manufactured in India under 'Make in India' programme in order to reduce the cost and make it affordable
2.	Some of the sensitive parts need to be imported	Need to be manufactured in India
3.	Small tank size, small volume of the liquid tanks, short flying time (Sizhe et al., 2017)	Optimum size of tank is to be decided and manufactured with less weight
4.	Permission from local police/authority	Government should liberalize this clause for the benefit of farmers, but, impose restrictions on herbicidal use
5.	If the rotational speed of the rotors is greater, chemical spread in the canopy will be unequal	Optimum speed of rotors and height of flying is to be worked out scientifically and maintained
6.	Obstacles like trees, hills, hillocks, big boulders may hinder operations with drones	Manual operation of drones is advocated rather automatic to avoid collisions

Table 2: Continue...

Sl. No.	Problem/constraint	Solution
7.	Less battery capacity. Frequent recharging of batteries is required during operations	High capacity batteries have to be manufactured or more no. of batteries have to be maintained with operator for uninterrupted work. Improve their capacity for working more than 100 cycles.
8.	Lack of availability of drones in all areas	Government has to encourage setting up custom hiring centers (CHCs) in mandal/district headquarters (Pathak et al., 2020)
9.	Requires skill for the operators/pilots	Provide capacity building and promote entrepreneurship
10.	Requires registration for drones from DGCA (Director General of Central Aviation)	Liberalize the procedures and improve the accessibility
11.	Lack of standard operating procedures (SOPs) and guidelines (Anonymous, 2020)	Central government has released SOPs and guidelines for safe use and productive use of drones by the government and educational institutions.
12.	Working in isolation	Need to encourage collaborative effort among personnel of Agriculture (Plant Protection, Ag. Engineering, Agronomy, Soil Science, Physiology etc.,), Ecology and Environment, Engineering and Information and Communication Technology (ICT).
13.	Small land holdings	Use drones with different capacities to cater to the needs of small, medium and large farm holdings

8. Conclusions and Future Perspectives

Drones have multifarious uses in Agriculture, but, there is a need to finalise standard doses for using different chemicals in different crops for safe and sustainable management of resources and effective management of abiotic and biotic stresses in this era of climate change. Studies are needed on biological effectiveness. India has to be careful while implementing the technology keeping in view of complete ban in Canada and European Union and restrictions in Switzerland and United States of America (USA).

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