

Drone application in rice cultivation:

Experiences from ICAR-IIRR trails

S Vijayakumar*, Hanuma Madireddy, Sai Charan Bhusarapu, R M Kumar and R M Sundaram

ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad, Telangana 500 030

Intercultural operation in rice like raising nursery, seedling uprooting, transplanting, herbicide spray, fertilizer application, insect and disease control is highly tedious and laborious involve lots of human drudgery. Agricultural workers mostly women are suffering from pain in the neck, shoulder, upper back, lower back and thighs because they are compelled to adopt bending and sitting posture during manual uprooting and transplanting of rice seedlings, and weeding. Drones and their applications have the potential to ease the cumbersome process in agriculture and reduce the labour burden on the farmers and farm workers. Drone technology also improves the efficiency of farmers and saves time, and production costs. Before promoting this technology for large-scale adoption, the standardization of operating protocol for pesticide (herbicide, fertilizer, insecticide, fungicide) spray, sowing and supplementary pollination is highly important.

Keywords: Drone, Rice Cultivation, Spraying

AGRICULTURE is one of the drudgery-prone occupations due to lack of access to advanced agricultural technologies. Manual rice transplanting, weeding and pesticide application are labour-intensive task and directly associated with human drudgery. The working conditions lack essential facilities; forces adoption of static and neo-neutral postures and unsupported positions; dependence on muscular force and strength which makes the work extremely laborious and energy intensive. High labour demand during the peak transplanting period adversely affects the timeliness of agricultural operations, thereby reducing crop yield. It is believed that the use of drones in agriculture will solve most of these problems. It reduces the labour requirement for sowing and pesticide spraying, and production costs drastically. It also reduces the time required for each operation thereby ensures the timeliness of all the operations in the field.

Several applications of drones in agriculture

- Crop scouting (counting number of plants per unit area) without entering the paddock is possible with drones.
- Drones can help in effective crop surveillance by inspecting the field with infrared cameras and optical sensors, and provides real-time information. Based on these information farmers can take active measures to improve the condition of plants in the field.
- Agricultural drones can be used for soil analysis to evaluate moisture content in the soil, terrain conditions, soil erosion and fertility of the soil.
- Drones can be used for spreading seed balls and sowing seeds as they have reservoirs, which can be filled with seeds.
- Drones equipped with thermal sensors can identify the parts of the field that have become dry which can be used to make

irrigation decisions promptly for precise and timely application.

- Pollination assistance in hybrid rice cultivation. Thrust (downwards pulling of air) generated from drone helps in shedding and dispersal of pollen grains over the A-line.
- Uniform spreading of granular fertilizers over the crop field. Drone spreader allows users to cover large area faster, more evenly and at a lower cost than ever.
- They can be widely employed for routine inspections following severe weather disasters like floods, cyclones, droughts, heat waves or fires.

Sowing of rice using drone

The spreading of rice seeds in the nursery can be carried out with the help of drones. It ensures the better spreading of seeds over manual spreading and also covers a large area in a quick time. This technology can also be useful in rainfed direct



Sowing of rice through drone under wet-direct seeded condition



Drone sown seeds under wet-direct seeded condition



Drone sown wet-direct seeded rice crop after 25 days of sowing

seeded rice where a higher quantity of rice is used for sowing. The footprint of the seed spreading person while walking inside the nursery field creates an uneven surface (potholes). Seeds which are fallen on the footprints of seed spreading person face waterlogging and subsequently poor germination. This problem is not arising in drone-based rice seed sowing. Experiments conducted at Indian Institute of Rice Research, Rajendranagar, Hyderabad, Telangana shows that, drones can complete the sowing of 1 acre of land in less than 10 minutes. Further research is required to develop drones which can sow rice seeds in line. The line sowing drone will be more useful in direct-seeded rice as it reduces the quantity of seed required for sowing and ensures optimum crop geometry for better light penetration. Ensuring optimum row spacing also reduces the competition between the rows. Soon, it is expected that budget-friendly drones will be used instead of huge tractors for crop sowing, as they emit harmful gases and pollute the environment in the process.

Pesticide spray using drone

Pesticides are frequently used in agriculture to prevent or manage insect pests, diseases, weeds and other plant pathogens in an effort to lower or eliminate yield losses and maintain good product quality. Serious concerns have been raised about the health risks associated with occupational exposure to pesticides as well as residues in food and drinking water, despite the fact that pesticides are developed in accordance with very strict regulations to ensure minimal

impact on human health and the environment. Farmers in developing nations face significant exposure risks due to the use of hazardous substances that are prohibited or restricted in other nations, improper application methods, outdated or completely inappropriate spraying equipment, poor storage procedures and the reuse of old pesticide containers for food and water storage. In some circumstances, exposure to pesticides might result from unintentional chemical spills, leaks or defective spraying equipment. Moreover, carrying backpack sprayers and walking in the puddled field needs a lot of energy and stamina and it also causes human drudgery. Proper application rates will be attained only if sprayers are in proper working order and calibrated correctly. A poorly calibrated sprayer could apply too little or too much chemical, resulting in unsatisfactory effectiveness or harm or death of the target being treated.

The use of drones for pesticide spraying will solve all these problems. Drone sprayers relieve workers from carrying backpack sprayers through fields, which can be harmful to their health. Drone-based pesticide spraying not only helps in saving time and labour costs significantly but also protects farmers from coming into contact with various toxic chemicals. Drones do not have any operational delays and can work double the speed of human labour. Drone provides constant pressure to ensure persistent droplet size. In order to keep the application rate and droplet size consistent during the application, it is crucial to maintain a

constant spraying pressure. Smaller droplets released from the drone nozzles ensure better spreading over the crop canopy. However, these small droplets may dry fast under hot and dry weather period which may be resulted in lower uptake and reduced efficiency of pesticide. Thus, though drone spraying ensures uniform application, its efficacy needs to be tested in the field as the spray volume is reduced in comparison to conventional spraying.

Herbicide spray using drone

Maintaining uniform deposition of chemical on the target is highly essential. A consistent walking pace must be kept throughout the process in order to keep the application rate comparatively constant. With manual sprayers, the travel speed will likely vary depending on the walking pace and the physical stamina of the person doing the spraying. Whereas, the use of drones ensures constant speed and pressure which in turn ensures a constant application rate. Experience from herbicide spraying using drones reveals the need for further research to standardize spray volume and concentration for better weed



Spraying of insecticide in rice using drone

control. The small spray droplet released from the drone nozzle increases the risk of drift by forming mist in the field. Even a small wind speed (>4 km/h) will increase the drift hazard in agriculture. The height of herbicide spray and wind speed at the time of spraying influence the drift hazard in the field. During the experimentation at Indian Institute of Rice Research, Rajendranagar, Hyderabad, Telangana we sprayed herbicide in rice fields at different heights using drones and our initial experience reveals spraying herbicide from 2.5–3 m height increase the drift hazard although it covers a large area (pesticide swath) in a single flight. Lower height (preferably 1.5 m) and still wind (4 km/h) reduce the drift hazard in the field. On the other hand, flying drone near the crop (1.5 m above the crop canopy) reduce the spraying swath and increase the time and number of flights required to cover the same area of land. The smaller drift-prone droplets are created in drone spraying due to higher pressure. Hence, reducing the pressure in the nozzle will increase the spray droplet size but increase the spray volume required for spraying.

Fertilizer application using drone

Traditional fertilizer broadcasting, which involves manually spreading fertilizer across the surface of crop fields, triggers



Drone attached with spreader for fertilizer application

inefficient fertilization and it is also highly tiresome process. When used in excess, nitrogen-containing fertilizers are one of the main causes of environmental deterioration. Uneven growth, GHG emissions, fertilizer waste and a decline in the plant's use coefficient occurs by uneven fertilizer broadcasting. Researchers recommend more number of split applications of nitrogen to increase nitrogen use efficiency. However, it also increases the labour requirement for fertilizer application. Thus, drone is the best option for farmers to reduce the labour requirement in agriculture. Initial experience shows spreading of granular fertilizers like crystal urea, DAP was feasible using drones. However, the spreading accuracy

needs to be improved in order to obtain better fertilizer spreading and higher nutrient use efficiency.

Supplementary pollination in hybrid rice using drone

Supplementary pollination in hybrid rice is the process of shaking the pollen parent (R line) so that the pollen grains are shed and effectively dispersed over the A-line parents (CMS-Cytoplasmic Male Sterile line). The timing and frequency of supplementary pollination are important factors for higher yield. The supplementary pollination should be given at peak anthesis time i.e. when 30–40% of the spikelets are opened for about 7–10 days. In conventional hybrid rice cultivation, supplementary pollination is done either by rope pulling or shaking the pollen parent with the help of two bamboo sticks. This process is repeated 3–4 times during the day at an interval of 30 minutes. The use of drones for supplementary pollination will lower the labour requirement and ensure timely pollination in hybrid rice. The thrust created by drones helps in better spreading and shedding of pollen parents. A rope attached to the drone helps in pulling pollen parents to spread the pollen grains. Initial experience shows that drones can cover a large area in a very short time and multiple pollinations can be provided to a large area with less manpower and time.



Post-emergence herbicide spray using drone in wet-direct seeded rice

Limitations of agricultural drones

- Drones are heavily dependent on good weather conditions. Under rainy or windy weather conditions, it is not advisable to fly drones.
- Using new technology is a welcoming change but using it daily requires the right skill set and adequate knowledge. An average farmer may struggle to understand drone functions. Either he must acquire the knowledge or remain dependent on an experienced person.
- Most of the drones have less flight time (between 15 minute to 30 minute) and cover less area. Drones having long flight times and long-range are costlier. Drones having more features like RTK (Real-Time Kinematic) and multiple payload compatibility (spreader, sprayer and sensor) are also more expensive.

- Need to obtain government clearance and license in order to use it.
- Purchasing drones equipped for agriculture could prove costly in the short run but worthwhile in the long run.

Way forward

Drone technology is going to change the agriculture sector. Their use is more beneficial for small farmers, but there is still a long way to go before they are included in every farmer's inventory, especially in developing countries. 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. Moreover, trained pilots are needed to take forward the still untapped drone market.

SUMMARY

Drone technology has gotten the majority of the industry's attention because of its diverse application and is considered the future of the agricultural community. Drones assist farmers to overcome many obstacles in addition to improving performance overall. Initial experiences from drone use in rice cultivation revealed that there is a lot of research required before its large-scale promotion. Thus, organizations like ICAR and SAU (State Agricultural Universities) should speed up their drone research programmes to enable the rapid formulation of regional-level standard operating protocols. Researchers are optimistic that drones will be able to address many challenges in agriculture, despite the need for more research in this field.

*Corresponding author's e-mail: vijitnau@gmail.com

HANDBOOK OF INTEGRATED PEST MANAGEMENT

To reverse the loss of environmental resources and also to reduce biodiversity loss, the Government of India has Integrated Pest Management (IPM) as part of the National Agricultural Policy. Integrated Pest Management emphasizes



the growth of a health crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. IPM is not new – mechanical, cultural and biological tactics were used by farmers for hundreds of years before chemical pesticides became available. Besides, there are IPM techniques that have been developed more recently and are effective in suppressing pests without adversely affecting the environment.

The task of spreading the message of IPM across is tough due to poor awareness about the subject among people in line-departments as also among the farmers. The information on integrated pest management as a whole is scattered. This *Handbook* comprehensively deals with all the aspects of integrated pest management in field crops, horticultural crops under traditional, protected systems. Information on basic strategies and tactics of different methods of management including mass production of biocontrol agents, IPM policy and pesticide registration is provided in comprehensive form.

The *Handbook of Integrated Pest Management* comprises 82 chapters which are well written in lucid language with crispy sentences by the renowned scientists. The role of IPM is elucidated with different pests like *Trichogramma*, *Bacillus thuringiensis*, *Nomuraea rileyi* etc. and agricultural crops like rice, wheat, maize, sorghum, pearl millet, pulses, soybean, rapeseed mustard, groundnut, minor-oilseed crops, sugarcane, cotton, jute and mesta, potato, vegetable crops, fruits, grapes, citrus, banana, pomegranate, coconut etc. This *Handbook* will provide information of available useful technologies to educate on how to reduce or judiciously use chemical pesticides, safeguard ourselves from chronic poisoning, save the National environment while also reducing input costs and raise farmers' income. This compilation will be useful to teachers, students, trainers, line-department personnel and policy makers.

TECHNICAL SPECIFICATIONS

No. of pages : i-x + 768 • Price : ₹ 1500 • Postage : ₹ 100 • ISBN No. : 978-81-7164-179-6

For obtaining copies, please contact:

Business Unit

Directorate of Knowledge Management in Agriculture

Indian Council of Agricultural Research

Krishi Anusandhan Bhavan-I, Pusa, New Delhi 110 012

Tel : 011-25843657, Fax 91-11-25841282; e-mail : bmicar@gmail.com