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AGRICULTURAL DRONE INDUSTRY INSIGHT REPORT

2024/2025

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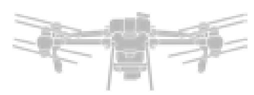
BETTER GROWTH, BETTER LIFE

CONTENS



INTRODUCTION

The international agricultural landscape in 2024 demonstrates remarkable vitality, with governments implementing friendly policy frameworks to accelerate smart farming integration and climate-resilient agricultural systems. This year, agricultural drones have provided superior solutions, liberated more productivity, and paved the way for more environmentally friendly and sustainable agricultural practices.

In 2024, with a global amount of 400,000 agricultural drones, DJI Agriculture witnessed the influx of more young pilots and an increasing number of women joining the agricultural drone industry. It also saw how agricultural drones have generated greater income for people, reduced pollution, and conserved more water resources. Due to the unique advantages of agricultural drones, they have helped save 222 million tons of water and reduce carbon emissions by 30.87 million tons of CO_2.

I.Events in 2024

January
Hosted several webinars to discuss drone solutions and precision agriculture with practitioners from around the world.

February
Participated in the 2nd Spray Drone End User Conference in the U.S. and introduced the local U.S. team and local service policies.

March
On International Women's Day, more than 12,000 women had joined the agricultural drone industry.

April
DJI Agriculture attend Agrishow, the Brazilian largest agricultural technology trade show, released the T50 and T25.

May
The T50 successfully completed the spreading of cover crops even on rainy days, helping German farmers recover from losses during heavy rains.

June
In Africa, DJI pilot trainers are helping farmers use DJI Agras drones to revolutionize agriculture, boost productivity, and create new jobs.

July
Conduct efficacy tests for fruit tree spraying in Japan.

August
Launch a global technical briefing for the T50 to introduce the new technologies featured in the T50

September
DJI Agriculture conducted an online live broadcast to provide after-sales policy interpretation for global users.

October
DJI Agriculture supported the FAO Science, Technology and Innovation Forum , advocating for water resource protection and food security.

November
DJI Agriculture hosted a visit from the Director-General of the South African Civil Aviation Authority and provided recommendations for the management of drones in South Africa.

December
DJI Agriculture shared case studies on rice operations to help farmers better explore best practices for drone-based rice cultivation.

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II.Global Policy Trends

The years 2024 to 2025 mark a period where the global application of agricultural drones is continually deepening. Some countries are transitioning from limited testing to formal application, while others are expanding from single-crop applications to a broad application across various crops. This progress is inseparable from the different open policies formulated by countries based on their own national conditions. Regardless of the specific regulation and implementation methods of these policies, the ultimate beneficiaries are the local farmers. The optimization of the policy environment accelerates the development pace of this industry and guides it towards a more standardized and orderly direction in different countries.

2.1. Brazil

2.1.1 ANAC with Scientific Management

After the Brazilian Civil Aviation Authority (ANAC) abolished the compulsory airworthiness management of agricultural drones in 2023, Brazil's agricultural drone industry experienced even more rapid development in 2024.

ANAC plays a pivotal role in enforcing drone regulations[1], overseeing registration, certification, and airspace management. The authority has also developed user-friendly systems for drone registration and flight authorizations.

In addition to ANAC, Brazillian drone regulatory landscape involves a range of authorities, including the Air Traffic Control Department, the National Telecommunications Agency, the Ministry of Agriculture and the Ministry of Defense. This collaborative approach ensures that drones are regulated across various sectors and domains.

2.1.2 MAPA Encourage the Standardized Training

In 2024, Mapa[2], as Brazillian agricultural authority, has repeatedly expressed concern for the agricultural drone industry and actively addressed issues faced by agricultural drones in Brazil, such as personnel competency standards and training.
MAPA presented at the Drone Show 2024[3], in São Paulo, updates to Brazilian standards for the use of drones in agriculture with a lecture by the head of MAPA 's Agricultural Aviation Division, Uéllen Colatto, on Tuesday, at Expo Center Norte.
In October 2024, MAPA issued Ordinance No. 1187 of the SDA/MAPA, soliciting public comments on a draft regulation titled "Regulation on the Training of Agricultural Drone Personnel." The purpose of this regulation is to prevent corruption and non-compliance in drone personnel training, aiming to establish a healthier agricultural drone industry. The regulation sets forth provisions in several areas, including:

- Requirements and procedures for registering agricultural drone operators and certifying educational institutions.
- Guidelines for agricultural drone courses.
- Requirements for operational planning and information recording.
- Rules for conducting agricultural drone operations.

In the future, MAPA plans to establish a digital platform for the digital management of agricultural drones.

1.See: https://l2baviation.com/l2b-global-aviation-news-drone-regulations-in-latin-america/
2.Ministry of Agriculture, Livestock and Food Supply: https://www.abc.gov.br/training/informacoes/InstituicaoMAPA_en.aspx
3.See: https://www.gov.br/agricultura/pt-br/assuntos/noticias/mapa-apresenta-normas-sobre-uso-de-drones-na-agricultura-na-drone-show

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2.2. Argentina

In July 2024, Decree No. 664/2024 and Decree No. 663/2024 were published in the Official Gazette of Argentina[4], further advancing the modernization and deregulation of the commercial aviation industry.
Regarding the regulation of drone usage, the main objective is to reduce restrictions on their deployment in agricultural areas. This strategic decision fully recognizes the significant growth potential that drones offer to the agricultural sector, enhancing land management efficiency, improving spraying operations, and optimizing seedling planting activities.
Through these regulations, unnecessary bureaucratic obstacles have been eliminated, streamlining the authorization process for private entities seeking to use drones in agriculture.
This approach not only promotes technological innovation but also ensures safer and more efficient operations across various sectors, aligning with global trends toward modernized aviation practices and sustainable development.

4.See: https://www.argentina.gob.ar/noticias/desregulacion-aerea-se-ordena-el-uso-de-drones-y-se-optimiza-el-espacio-en-aeropuertos

2.3 Chile

In 2024, the Chilean Ministry of Agriculture provided further support for agricultural drones. Corresponding efficacy tests were conducted locally, offering guidance for the use of drones on cherry.

2.4. United States

2.4.1 FAA Simplify the Application Process

According to the FAA's requirements, if agricultural drones are used for spraying economic poison and fall within the Part 137, they can apply for exemptions according to 44807.

In February 2024, the FAA released a list of exempted models. Local users who have obtained operating exemptions and have indicated "all exempted models can be used" on their exemption authorization letters can directly use the models on the list. In 2024, FAA updated the approval list for 3 times, the latest update in 2024 is on 3rd, October. DJI's agricultural drones weighing more than 25 kg are all on the exemption list, especially for the current popular models T50 and T25.

In 2024, the Federal Aviation Administration (FAA) approved the simultaneous operation of multiple agricultural drones, allowing a single pilot to control up to three aircraft. This initiative opens up more technical development opportunities for future agricultural drone operations. Additionally, the approved weight limit for agricultural drones has also increased.

List of Approved UAS under Section 44807

Note: this list is for reference purposes only, and does not grant any Operator with authorization to operate any UAS on this list. Only Operators holding a valid grant of exemption under Section 44807 for specific UAS approved for use on their exemption may conduct operations with that UAS in compliance with the Conditions and Limitations of their Exemption.

Make	Model	Approved Maximum Take-Off Weight (MTOW), incl. Payload	Approved For Part 137 Agricultural Operations
AgrowDrone	UAS-e-M5	80.5 lbs.	Approved
AgrowDrone	UAS-e-M10	146.6 lbs.	Approved
AgTS	FireEye	75.8 lbs.*	
AiRanger	UAS	220 lbs.	
Amazon	MK27	88 lbs.	
Amazon	MK30	83.05 lbs.	
BFD Systems	GD40	120 lbs.	
BROUAV	U30L-6	146.6 lbs.	Approved
BROUAV	52L-8	264.55 lbs.	Approved
BROUAV	D-72L-8	324.08 lbs.	Approved
Chengdu JOUAV Drone	CW-30	75 lbs.	
DJI	Agras T16	92.6 lbs.	Approved
DJI	Agras T20P	127.86 lbs.	Approved
DJI	Agras T20	104.5 lbs.	Approved
DJI	Agras T25*	127.8 lbs.	Approved
DJI	Agras T30	171.96 lbs.	Approved
DJI	Agras T40	222.66 lbs.	Approved
DJI	Agras T50	227.07 lbs.	Approved
DJI	FlyCart 30	209.73 lbs.	Approved

FAA's approval list and DJI models

Unlike the previous three years, when the FAA required extensive documentation for agricultural drone operation exemption applications, in 2024, the FAA published a simplified application process for Part 137 on its official website. Applicants can now submit their requests by filling out forms. This change has saved farmers a significant amount of application time and reduced compliance costs considerably.

"There's a new streamlined process for those applying for a Part 137 UAS certificate[5]. This allows the FAA to streamline both the Part 137 agricultural UAS certification and the drone exemption process for visual line of sight (VLOS) operations conducted within the altitude and airspeed limitations stipulated by the exemption.

Applicants are no longer required to submit documents to their local Flight Standards District Office. Instead, the applicant must complete FAA Form 8710-3 and submit their exemption number to UAS137Certificates@faa.gov for the FAA to begin the certification process."

2.4.2 USDA

In 2024, the United States Department of Agriculture (USDA) has continued its research initiatives on agricultural drones to guide safer and more efficient drone operations in farming. These projects focus on pesticide drift mitigation, precision agriculture, and productivity enhancement, providing critical data for shaping drone-related agricultural policies.

In August 2024, the USDA's Natural Resources Conservation Service (NRCS) released a case study highlighting advancements in forestry applications using agricultural drones[6]. The report underscores innovations such as LiDAR technology and 3D multispectral imaging, which significantly improve forest management, crop monitoring, and yield prediction accuracy

"Drones can be utilized for environmental monitoring, allowing for the tracking of soil erosion, water quality, and vegetation health. In times of disaster, drones prove invaluable in assessing damage quickly, aiding in relief efforts and decision-making. Furthermore, in the realm of precision agriculture, drones provide vital data for optimizing crop yields and managing agricultural resources effectively."

5.See: https://www.faa.gov/uas/advanced_operations/dispensing_chemicals
6.See: https://www.nrcs.usda.gov/news/harnessing-the-power-of-drones-for-improved-efficiency-and-data-collection

2.5. Canada

2.5.1 Transport Canada

In February and March 2024, agricultural drone users began to successively receive approvals from Transport Canada for the T50 and T25 models. Transport Canada published an application form for a Special Flight Operations Certificate (SFOC) on its official website, providing convenience for agricultural drone users to apply.

2.5.2 Health Canada

Health Canada has adopted a whitelist approach for pesticides used by drones[7], rather than directly classifying drones under the broader "Aircraft" category. The regulation is as follows:

"Transport Canada regulations consider drones to be aircraft. However, when registering pesticides, Health Canada distinguishes drones from aircraft as they present distinct features, such as a lower load capacity and flight time, access to remote sites or crops on wet soil, different risks of exposure for the person handling the pesticide and to the environment.

As a result, the use of drones for pesticide application is subject to its own Health Canada efficacy and risk assessment, specific to this type of equipment. Drone application can only appear on product labels once the risks and value have been considered acceptable by Health Canada."

The application of a pesticide by drone requires that this method of application to be approved for this given pesticide. The label must include the directions for drone use, including any limitations on its use and procedures to reduce risks associated with drone application.

Labels of products registered for drone application bear the words "Remotely Piloted Aircraft System" or "RPAS".

2024 Health Canada Pest Management Regulatory Agency (PMRA) has approved its first herbicide for drone application in Canada[8]. Corteva has received approval for adding remotely piloted aircraft systems (or drones) as an application method on the label of Garlon XRT. It's a Group 4 herbicide, which contains triclopyr, and is used for controlling woody plants and vegetation in non-crop settings, such as around power lines and other utilities.

7.See: https://www.canada.ca/en/health-canada/services/publications/product-safety/pesticide-application-drones.html
8.See: https://news.agropages.com/news/NewsDetail---50862.htm

2.6. Europe

2.6.1 EU Commission

In 2024, the number of drones in EU member states saw a significant increase, accompanied by further progress in advancing the legislation of the previously drafted SUD Act (proposed in 2023).

In 2024, the European Union officially clarified in its response to agricultural drone applications that their use in agriculture is not prohibited, provided that safety requirements are met. The EU also highlighted ongoing research projects aimed at exploring the benefits of drones in agriculture, future development directions, and the construction of digital platforms.

As in the answer[9]:

"While the Commission proposal for a regulation on the sustainable use of plant protection products has been withdrawn, this directive remains in force.

Derogations to permit aerial spraying (including by drones) are possible in special cases subject to certain conditions. Aerial spraying must represent clear advantages in terms of reduced impacts on human health and the environment compared to other methods, or where there are no viable alternatives, provided that the best available technology to reduce drift is used.

The plant protection products must be explicitly approved for aerial spraying, the operator and the enterprise responsible must be certified. Risk management measures are needed in areas close to the public and aerial spraying is not to be carried out near residential areas. Member State competent authorities are responsible for examining and approving requests for derogations.

An Organization for Economic Cooperation and Development (OECD) subgroup is addressing this topic also.

The Horizon Europe projects ICAERUS, SPADE, and CHAMELEON are testing the use of drone solutions for spraying and other uses in agriculture.

It should be noted that the EU legislative framework for drones does not prevent the use of drones in agriculture. Predefined Risk Assessment (PDRA) S-01, developed within the mandate given in Article 11 of Regulation (EU) 2019/947, provides a framework for agricultural works, including spraying."

9.See: https://www.europarl.europa.eu/doceo/document/E-9-2024-000920-ASW_EN.html#def4

In December 2024, led by Portugal, the governments of different Member States raised the discussion on the plant protection and the use of drones at the Council meeting, urging the expedited adoption of the SUD Act, supported by Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, Italy, Latvia, Lithuania, Romania, Slovakia, Spain and Sweden. In the AOB item:

"Drones are expected to enable targeted application of pesticides used in plant protection under specific conditions, increasing the efficiency and precision of their use, contributing to the reduction of the quantities of used pesticides along with the potential to reduce risks to human health and the environment, compared to the use of professional aerial or ground equipment.

......

Given the technological advances in recent years in the field of precision farming tools, it is important to recognize the role to be played by drones, thus enabling a combined action between monitoring, data management and analysis and decision-making, thus contributing to the sustainability of the sector in environmental, economic and social terms and the sustainable use of pesticides.

However, to guarantee the sustainability and safety of the use of this technology, it is necessary to know and consider the different factors that have the potential to constrain it, which is why it is necessary to establish appropriate requirements and regulations for the use of this type of aircraft. We therefore call on the Commission to present, without delay, clear guidance and a proposal on the use of drones for the application of plant protection products, including procedures for risk assessment and risk management and the inclusion of certain criteria such as those already identified in the draft SUR regulation."

2.6.2 EU Member States

1). Spain

In May 2024, AESA launched an electronic platform for the approval of PDRA (Pre-Defined Risk Assessment) applications. Additionally, AESA reinterpreted the 3-meter size limit for multi-rotor drones in the PDRA framework. The 3-meter restriction was changed from measuring the distance from the tip of one propeller to the tip of the opposite propeller to measuring the distance from motor to motor, effectively ignoring the propeller dimensions.

This reinterpretation, aligning with the requirements of SORA 2.0, facilitates a simplified approval process for more agricultural drones, thereby promoting their wider adoption and operational efficiency.

In January 2025, AESA released the performance results of its PDRA (Pre-Defined Risk Assessment) electronic platform since its launch.

"AESA also published a new rapid risk assessment specific to phytosanitary operations (PDRA-01-F) with UAS of up to 3 meters, adapted to aerial work of fumigation and dispersion of agricultural/forestry products. Since the publication of this PDRA 01-F, the Agency has processed 160 agricultural applications, authorizing 120 of them under this new procedure. This fact is a good example of AESA's work to streamline the administrative procedures of the sector, also contributing to the application of UAS technology to other sectors." [11]

This indicates a significant improvement in the management and regulatory processes for agricultural drones in Spain, reflecting a more advanced and efficient level of oversight.

10.See: https://www.parlament.gv.at/gegenstand/XXVIII/EU/5516
11.See: https://www.seguridadaerea.gob.es/en/noticias/espana-supera-los-119000-operadores-de-drones-registrados-en-la-agencia-estatal-de

2) Germany

In 2024, the LBA published guidance for SORA and templates for operation manuals on its website, making it easier for applicants to fill out the necessary documents. This initiative provided convenience for many users of agricultural drones.
In 2024, JKI, the German authority responsible for certifying agricultural drones, conducted drift tests on the T25. The T25 and T30 were included in the same drift test to compare the drift characteristics of these two drones with similar payloads. JKI also carried out certification inspections on the T25 and T50 drones.

2.7. Australia

2.7.1 CASA

In May 2024, CASA published a new policy titled "Drones taking agriculture sky high" on its official website, which sorted out the management methods of agricultural drones, from registration to safe use, and the need to comply with the management tips of the local spraying.
The complete guidance[12] of the entire process by CASA represents recognition of the development of local agricultural drones. In the guide, special mention is made of the relaxed management of use on personal land, and no need for special authorizations when operating in accordance with safety guidelines. "There are no CASA authorizations required to conduct spraying operations when operating one drone on your own land. However, it's important you also check the local state or territory laws for aerial distribution where you intend to conduct spraying operations."

At the same time, CASA has opened compliance application channels and operation guidance for beyond visual range operations, extended visual range operations, and cluster operations.
"We recognize the benefits that drones can deliver in agricultural operations, including improved efficiency and reduced costs. With the rapidly growing popularity and innovative advancements in the RPAS industry, we continue to work with industry to review and update our regulations as necessary to make sure they stay relevant while supporting new technologies and safety", from CASA.

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2.7.2 APVMA

In 2024, APVMA released the Corporate Plan[13] to support the development of local agriculture.
"Precision agriculture, also known as precision farming, uses technology to improve agricultural productivity and sustainability. It provides farmers with detailed information about their crops and fields that in turn enables greater control over the operations and more informed decision making. The use of drones and fully automated systems are also becoming common place in farming operations in Australia.
To be satisfied that a chemical is safe for use, the APVMA must be confident that the technology used, the method of application, and relevant safety controls presented on the label ensure appropriate safeguards and protections for the health and safety of people, animals and the environment, as well as trade.

New approach methodologies (NAMs) are innovative scientific approaches that aim to provide more accurate, efficient and more humane methods for assessing the safety and efficacy of chemicals while reducing the reliance on using vertebrate animals as surrogates for humans in the testing of new chemicals and products. They include many in vitro and in silica techniques. Across the world, NAMs are being adopted by the chemical industry and regulators in testing due to their ability to generate information more efficiently and humanely for registration and in doing so more effectively protect human health and the environment. "

12. See: https://www.casa.gov.au/about-us/news-media-releases-and-speeches/drones-taking-agriculture-sky-high

13.See: https://www.apvma.gov.au/sites/default/files/2024-07/APVMA%20Corporate%20Plan%202024%E2%80%9325.pdf

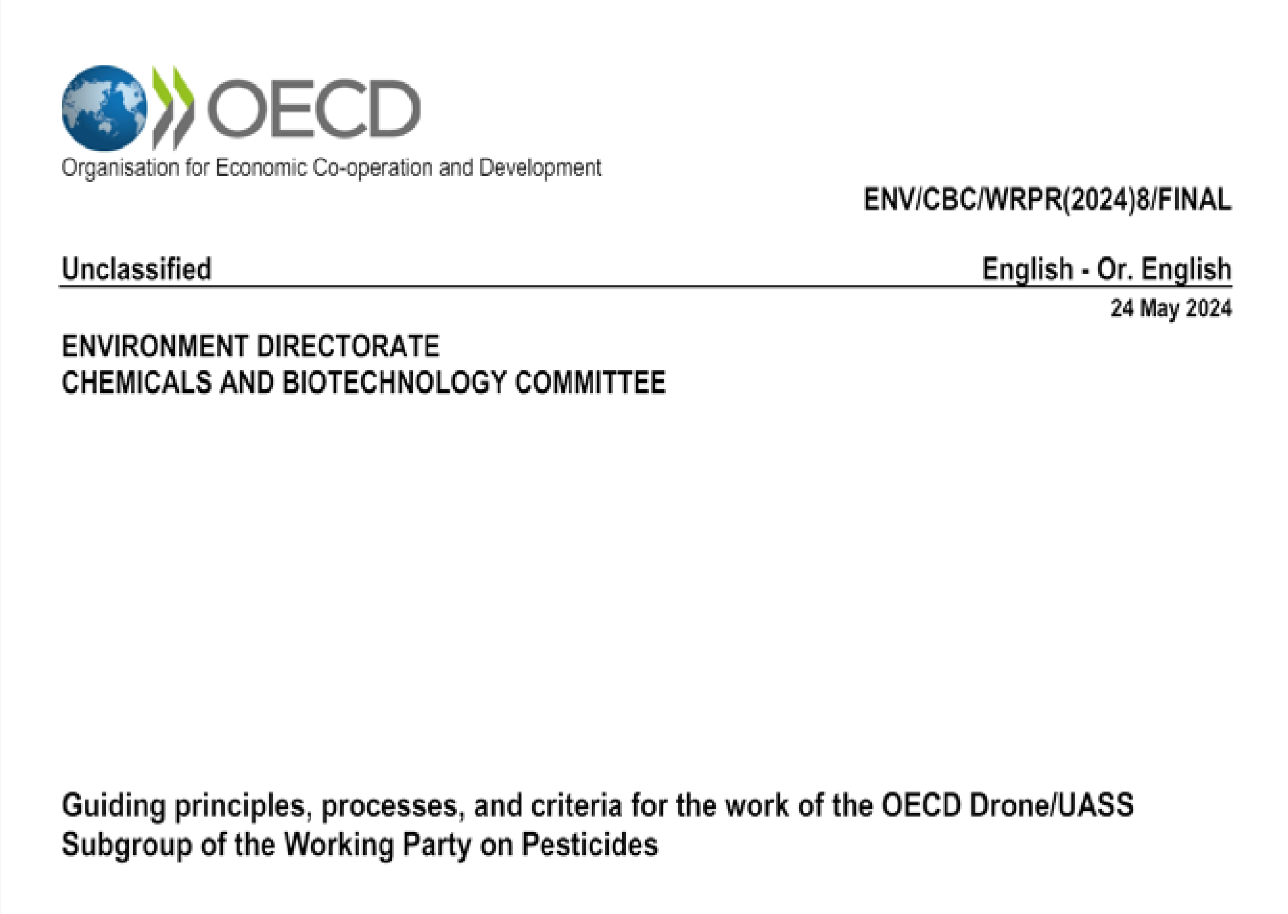
2.8. China

From January 1st, 2024, the "Interim Regulations on the Management of Unmanned Aircraft System " was officially taken into effect. Throughout the year, the operation of agricultural drones became more standardized, with pilots obtaining certifications directly from manufacturers. In 2024, DJI's T50, T25, T40, and T20P models received official airworthiness certificates issued by the civil aviation authority.

2.9. International Organization

2.9.1 OECD

In 2024, the OECD released Guiding principles, processes, and criteria for the work of the OECD Drone/UASS Subgroup of the Working Party on Pesticides to accelerate the advancement of agricultural drone applications.


OECD
Organisation for Economic Co-operation and Development

ENV/CBC/WRPR(2024)8/FINAL

Unclassified — English - Or. English

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ENVIRONMENT DIRECTORATE
CHEMICALS AND BIOTECHNOLOGY COMMITTEE

Guiding principles, processes, and criteria for the work of the OECD Drone/UASS Subgroup of the Working Party on Pesticides

2.9.2 FAO

In 2024, DJI[14] showed its agricultural drone solutions at the FAO Science, Technology and Innovation Forum, demonstrating to agricultural practitioners worldwide the advancements that drones bring to farming. The exhibition highlighted how the beauty of technology is transforming agriculture and changing the world.

2.9.3 ISO

In 2024, ISO 23117-2 international standard was in the process. And the standard published in 2025[15] specifies field measurements of spray deposition to determine the quantity and distribution of spray in a plane surface area in the transverse direction to the flight direction, treated by specific Unmanned Agricultural Aerial Sprayer (UAAS) with downward directed application. These field measurements can be used to determine the effective swath width of UAAS.

This document is not appropriate for evaluating spray deposition within a crop canopy (three-dimensional deposition). It is not appropriate for those spraying systems which rely on the presence of a crop canopy for efficient spray deposition (for example directed spraying, electrostatic charged spraying, very fine sprays). The purpose of establishing this standard is to reduce the potential environmental pollution risks during use from the perspective of design and performance.

14.Aermatica 3D, as DJI partner, showed in the forum, see their website https://www.aermatica.com/en/drones-for-agriculture-2/
15.See: https://www.iso.org/standard/81053.html

III. Agricultural Drone Tests

In 2024, DJI conducted drifting tests and efficacy tests around the world to further explore anti-drift design and best practices for drones. In this process, with a comparison of the tests in 2021-2023, there are some similar results of the tests.

3.1 Drifting Tests

From 2021 to 2024, multiple institutions and universities worldwide conducted drift tests for agricultural drones. DJI Agriculture also collaborated with various partners globally to carry out drift tests for different drone models. Through these studies, several key points of consensus were reached:

The drift caused by drones is less than that caused by traditional aircraft (e.g., helicopters, small agricultural fixed-wing planes).

The drift caused by drones is slightly more than that caused by small ground-based equipment (e.g., manually backpack sprayers, small boom sprayer).

When compared with large ground-based equipment, drones exhibit similar drift patterns due to their comparable operating heights.

Between 2022 and 2024, all trials led by DJI Agriculture strictly followed the ISO 22866 standard for spray drift field testing. Through continuous exploration, the sampling and analysis methods for drift tests have been continuously improved.

3.1.1 Collection Devices and sampling point

Ensure the accuracy of the sampling results as much as possible, the placement of sampling points is determined based on specific conditions. However, depending on the requirements of data analysis, the arrangement and method of sampling points could be different.

For example, in the T30 trials conducted in 2022, a droplet collection device was placed every 1 m between the downwind edge of the operational area and the downwind drift zone at 10 m. These devices consisted of Mylar sheets as the base support, with droplet test cards and 9 cm diameter filter papers fixed onto the Mylar sheets. This design minimized cross-contamination between individual collection devices and reduced interference from personnel during the experiment. Additionally, droplet collection devices were placed at distances of 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 45, and 50 m downwind from the edge of the operational area. All sampling devices were positioned 1 m above the ground to avoid ground effects on droplet deposition. After spraying, the devices were left undisturbed for 5–10 minutes to ensure that all droplets on the filter paper had dried completely.

the filter paper had dried completely. The samples were then sequentially placed into self-sealing bags and stored in a shaded, cool environment before being processed and analyzed.

The data collected in this trial will be further used for model training. Therefore, a large number of sampling points were set up, with nearly 300 sampling points per trial and a total of approximately 10,000 sampling points for the complete trial dataset.

In the T40 trial conducted in 2022 and the T50 trial conducted in 2023, both ground-based and airborne sampling points were established, with airborne sampling points distributed at different heights. Specifically:

Ground Droplet Deposition Collector: To collect the distribution of droplet deposition in the operational area of the agricultural drone, PVC card supports were placed in the center of the drone's operational area to collect deposited droplets. The droplet collection strip was perpendicular to the drone's flight direction, with a collection width of 30 m (3 spray widths). Each group consisted of 13 points spaced 2.5 m apart, extending from the upwind side to the downwind edge, with a total of 3 groups and 39 points. During use, the PVC cards were kept parallel to the ground.

Ground Drift Collection Device: To collect the drift distribution of the agricultural drone on the ground downwind, 9 plastic Petri dishes with a diameter of 15 cm were placed at distances of 3, 5, 10, 15, 20, 30, and 50 m downwind from the edge of the drone's spray width. These dishes were placed on 3 metal plates, aligned in a straight line parallel to the drone's travel direction.

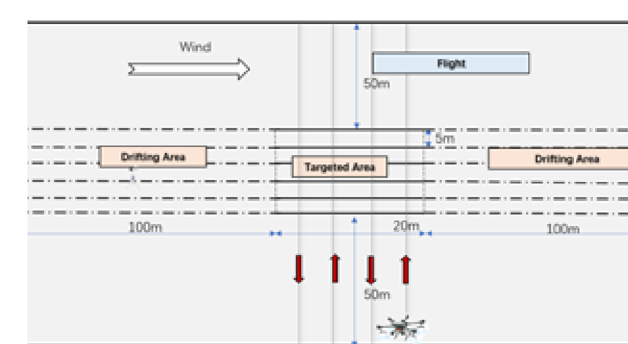
Airborne Drift Collection Device: To collect airborne drift droplets downwind, 3 sets of airborne drift collection frames were placed 2 m downwind from the edge of the spray width. Starting at 0.5 m above the ground, each frame had 2 m long, 1.98 mm diameter

polytetrafluoroethylene (PTFE) wires spaced 50 cm apart, extending up to 5.0 m. Additionally, at 15 m downwind, 3 sets of 2.0 m × 2.0 m airborne drift collection frames were placed, with PTFE wires arranged similarly at 50 cm intervals. Each test group consisted of 42 PTFE wires. The ends of the PTFE wires were clamped to vertical frames and kept taut to ensure no bending occurred.

This comprehensive setup allowed for detailed analysis of both ground-level and airborne drift patterns, contributing valuable data to the ongoing improvement of agricultural drone technology.

3.1.2 Drifting Area and Deviate Area

In traditional testing studies, only deposition zones and drifting areas are typically established. However, after lots of tests, droplets affected by crosswinds exhibit a certain degree of deviation (usually 5–10 meters), which is considered normal. Consequently, researchers categorize this phenomenon as the "offset area" or “deviation area” during data analysis, excluding it from drift value calculations.



Schematic Diagram of the drifting test

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3.1.3 Similar Test Results

Despite testing different aircraft models and selecting various locations, field test conclusions were consistent, identifying the following factors as influences on drift:

Crosswind Speed: For agricultural drones, crosswind speed is the primary factor affecting the deposition rate of spray droplets in operational areas, as well as the cumulative drift amount in drift areas, the 90% cumulative drift distance, and the total drift distance.
When the crosswind speed is between 1.5–3.4 m/s, spray droplets will deviate 0–5 m downwind in multi-spray operations.
At crosswind speeds of 3.4–5.4 m/s, the deviation increases to 2–10 m. The greater the crosswind speed, the higher the cumulative drift rate of spray droplets in ground drift areas. In low wind speed conditions, ground drift is not apparent, and operations are recommended.

Flight Altitude:
At crosswind speeds of 1.5–3.4 m/s, the cumulative drift rate and 90% cumulative drift distance in drift areas increase with higher flight altitudes of 2 m, 3 m, and 4 m.
At crosswind speeds of 3.4–5.4 m/s, the deposition rate decreases with increasing altitude, with less uniform distribution in operational areas. Higher altitudes result in higher cumulative drift rates in both ground and aerial drift areas. Lower flight altitudes are advisable when crosswind speeds exceed 3.4 m/s to minimize drift.

Flight Speed: There is a positive correlation between flight speed and drift distance; as flight speed increases, drift distance becomes longer under certain crosswind conditions.

Droplet Size: Testing droplet size ranges of 80–100 μm, 250–300 μm, and 420–500 μm showed:
A positive correlation between droplet size and deposition rate in operational areas, indicating that larger droplets have higher deposition rates.
A negative correlation between droplet size and cumulative drift rate, 90% drift distance, and total drift distance, meaning larger droplets have lower drift rates, and shorter 90% cumulative drift distances.

3.1.4. Anti-Drift Design

a. Optimize nozzle design to increase the number of coarser droplets.
b. Enhance the drone's airflow dynamics to utilize the downwash and press the spray droplets onto crop surfaces to promote deposition.

3.1.5. Operational Guidelines to Minimize Drift

c. Select low wind speed conditions for operations. Before starting, inspect fields to ensure that there are no water bodies or sensitive crop areas downwind. Avoid spraying herbicides if wind speed exceeds 3.4 m/s.
d. Use appropriate flight altitudes and speeds, avoiding overly high or fast parameters.
e. Adjust droplet size based on different pesticides and field conditions.

3.2 Modeling the Drone Drift

With the growing application of agricultural drones in precision agriculture, the simulation of droplet deposition and drift has become an important predictive tool for spraying performance, significantly reducing experimental costs and time. By calculating the unsteady downwash flow field generated by the rotor motion of the drone, and solving the motion trajectory of discrete phase particles, one can predict the deposition and drift patterns of liquid droplets. These predictions consider the influence of the evolution of the rotor tip vortex structure and the interaction between the ground crop canopy and rotor downwash airflow. By introducing models such as evaporation and canopy effects, the precision of simulations can be further enhanced.

Currently, major modeling approaches include inviscid models (such as AGDISP and CHARM models), the finite volume method, the finite difference method, and the lattice Boltzmann model, among others. However, most existing research has focused on traditional fixed-wing and single-rotor drones. Due to the complexity of the wind field generated by multi-rotor drones, the accuracy of simulation predictions is limited. Enhancing the accuracy of these predictions in the context of multi-rotor wind fields to improve the efficacy of agricultural drone spraying is of great significance for the future.the article "Validation of the spray drift modeling software AGDISPpro applied to remotely piloted aerial application systems". [16]

"Both RPAAS design and their application technologies continue to evolve, with spatial uniformity of spray patterns one area of focus. Given the promising simulation results obtained in this study and the continued improvement in RPAAS spray technology, we anticipate that the ability of AGDISPpro and other models to accurately predict off-target spray drift deposition from RPAAS will continue to improve. Further research considering pesticide applications from additional RPAAS aircrafts with field studies designed explicitly for model validation should be conducted to more comprehensively validate AGDISPpro for use in regulatory decision-making"

16.See: https://www.sciencedirect.com/science/article/pii/S0048969725003596.

3.3 Large Model for Advanced Spraying Plan

A new model called YOLO-Fi was invented to help set the spraying plan. In the article "Precise extraction of targeted apple tree canopy with YOLO-Fi model for advanced DRONE spraying plans" [17]

"The precise analysis of individual fruit tree canopy information for accurate navigation and spraying operations of plant protection machinery is important for intelligent orchard management. However, in the complex environment of an orchard, it is quite challenging to simultaneously accomplish the detection, localization, and segmentation of tree canopies to enable precise spraying. Fortunately, advancements in high-performance unmanned aerial vehicle (DRONE), sensors, and deep learning algorithms have made it possible to quickly extract and analyze tree information from complex backgrounds. In this study, we proposed a comprehensive operational framework based on DRONE data and deep learning algorithms to accurately obtain apple tree information, thereby enabling variable targeted spraying. First, the Max-Relevance and Min-Redundancy (mRMR) algorithm was used to select three features (RVI, NDVI, SAVI) to create fused images to enhance tree canopies from the background environment, and the enhanced images were then utilized to generate a labeled sample dataset. Secondly, leveraging the labeled dataset, the YOLO-Fi model was developed. Using this optimal model, precise detection, localization, and segmentation of fruit trees in the experimental area were conducted. Our results showed that the YOLO-Fi model achieved optimal results (FPS = 370, mAP50-95 (B) = 0.862, mAP50-95 (M) = 0.723, MIoU = 0.749). Subsequently, based on the segmented areas of the fruit tree canopies, a variable spraying prescription map was generated, contributing to a 47.92% reduction in spraying volume compared to direct spraying. Finally, the ant colony algorithm was employed to design the shortest path for the plant protection DRONE to traverse over each fruit tree within the experimental area, leading to a 2.04% reduction in distance compared to the conventional DRONE flight path. This research can provide a comprehensive scheme for DRONE-based precision management in orchards, encompassing tree canopy monitoring, analysis, localization, navigation, and precise spraying."

17.See: https://www.sciencedirect.com/science/article/pii/S0048969725003596.

IV. Drone Application

The application of drones extends beyond field crops to include orchard management; it encompasses not only spraying operations but also spreading tasks. New scenarios and innovative application methods are providing more farmers with cost-effective management solutions.

4.1 Spraying Application

4.1.1 Drones are Revolutionizing Corn Farming

Corn has been cultivated for over 9,000 years, originating in southern Mexico. Today, it's one of the most productive crops worldwide, with major producers like the United States, China, and Brazil. In 2020 alone, global corn production reached 1.16 billion tonnes.

Before drones revolutionized agriculture, farmers relied heavily on ground sprayers for applying pesticides and fertilizers. This approach was often labor-intensive, time-consuming, and lacked precision. Without drones, these tasks took significantly longer and incurred higher costs.

Traditional methods often led to uneven applications, resulting in chemical wastage and less effective pest control. Additionally, ground sprayers struggled to access all field areas, leaving some sections untreated. After rainfall, tractors were unable to operate on wet fields, causing farmers to miss critical pest control windows.

When it comes to tractors, there are significant limitations and drawbacks to their use in spraying corn:

a) As the tractor sprays between rows, it may damage approximately 5.3% of the crops. This 5.3% damage is derived from the equation: (40 cm width per wheel * 2 wheels * 1,000 m field length = 800 square meters, divided by 15 m spray width * 1,000 m field length). This results in a yield loss of about €47.7-63.6 per hectare per season, depending on the 2023 sales price and yield (calculated as 5.3% of €150 per ton for 6-8 tons per hectare).

b) The operation has low efficiency, covering only 25-30 hectares per day over 10 hours using a small boom sprayer.

c) High labor requirements and costs are a concern: it takes €50 per day for a tractor driver and another €50 for a second driver who brings water for mixing chemicals. Initially, an additional €50 is needed for three more people to help measure the 15-meter spray width on a tractor without GNSS navigation. Overall, 2-5 people are required, leading to substantial costs.

d) Running a ground sprayer consumes significant fuel, costing €12.96 per hectare (€1.62 per liter for 200 liters of diesel across 25 hectares).

e) Ground sprayers also waste 400-500 liters of water per hectare after chemical mixing, a critical issue in water-scarce regions. The need for continual water transport further reduces spraying efficiency.

f) After rainfall, it's necessary to wait at least 1-2 days before a tractor can enter the field to spray, which prevents it from getting stuck in mud but also hampers corn growth to some extent.

g) In the later stages of corn growth, it's difficult or impossible for tractors to access the field, leading farmers to potentially abandon pest prevention or control measures, which can decrease corn yield.

Agricultural Drone Industry Insight Report

Adopting drone technology in agriculture offers numerous advantages that address the shortcomings of traditional methods. DJI drones offer exceptional precision and efficiency in spraying and spreading applications, ensuring even distribution of fertilizers, pesticides, and herbicides, which reduces waste and increases effectiveness. By lowering the need for heavy machinery and extensive labor, drones cut operational costs. They also enhance crop health and yield through targeted applications that apply treatments precisely where needed, minimizing crop damage. Additionally, drones improve safety by eliminating risks to human operators and reduce environmental impact by minimizing chemical runoff and soil compaction.

Benefit	Data
No crop damage and yield loss from wheel tracks	Drone increases income by €45.00-60.00/ha/season
Saving chemical use, protecting the environment	25% chemical savings; Chemical cost: €50-80/ha/time, saving €36-60/ha/season
Significant fuel savings compared to ground sprayers	€0.81/ha needed, saving 93% fuel cost; (€0.81/ha = €1.62/L gasoline * 25 L gasoline/50 ha used)
Decreased labor requirement and cost	1-2 people for T30 or T50 operation costing €50-100; Tractor requires 2-5 people costing €100-250
Higher efficiency than small & middle-sized ground sprayers	Drone: 50-80 ha/day; Tractor: 25-30 ha/day, increasing efficiency by 66%-220%
Saving water resources and alleviating agricultural water problems	Drone: 10-20 L/ha; Tractor: 400-500 L/ha, saving about 95% water usage
Timely response minimizes potential losses with post-rain spraying	Drone can start spraying 1-2 hours after rain

To maximize the benefits of drone technology, it's crucial to follow best practices tailored to your specific needs. Here's a recommended setup:

	DJI Agras T40/T50--herbicide	DJI Agras T40/T50--insecticide/fungicide/foliar fertilizer	DJI Agras T30--herbicide	DJI Agras T30--insecticide/fungicide/foliar fertilizer
Application Rate (L/ha)	15-25 L/ha	10-20 L/ha	15-25 L/ha	10-20 L/ha
Droplet Size (μm)	250-400 μm	100-300 μm	XR110015VS	XR11001VS
Flight Speed (km/h)	20-25 km/h	20-25 km/h	18-20 km/h	20-23 km/h
Route Spacing (m)	6-6.5 m	7-9 m	5.5-6 m	6-6.5 m
Height Above the Crop (m)	3-3.2 m	3-3.5 m	2.2-2.5 m	2.5-3 m

Best practice: Brazil

Corn stands as one of Brazil's most vital crops, playing a pivotal role in the nation's economy and food supply. Brazil ranks among the world's top corn producers, with regions like Montanha-ES significantly contributing to its agricultural success. In this region, corn is a staple crop, extensively cultivated by farmers who depend on it for their livelihoods.

The landscape of corn farming in Brazil is experiencing a remarkable shift due to the innovative use of drone technology. This integration is revolutionizing how Brazilian farmers manage their crops, optimize yields, and enhance sustainability. This article delves into the challenges, benefits, and practical applications of drone technology in Brazilian corn farming, offering valuable insights for agricultural innovators, drone enthusiasts, and the farming community.

Despite its significance, corn farming faces numerous challenges. Corn in Brazil is threatened by a range of pests, including corn earworms and fall armyworms, as well as fungal diseases like gray leaf spot and northern corn leaf blight. Invasive weeds such as Palmer amaranth further complicate the scenario.

These pests cause direct kernel damage, plant defoliation, and root destruction, leading to reduced yields and poor crop quality. Traditional farming methods often fall short in addressing these issues effectively and economically. This is where drones make a transformative difference.

The farmers deployed the Agras T50 in the spraying season between October and December, a critical period for pest and disease management in corn farming. A combination of insecticides, fungicides, and foliar fertilizers was used. The specific chemicals included:

Insecticides: Targeting corn earworms and fall armyworms.

Fungicides: Addressing fungal diseases like gray leaf spot.

Foliar Fertilizers: Enhancing overall crop health and yield.

The workflow involved mapping the operation area, flight planning, and executing automatic spraying using the DJI Agras T50 drone.

Detailed operation parameters included:

Drone Model	Agras T50
Operation Mode	Automatic
Application Rate (L/ha)	10 L/ha
Droplet Size (μm)	300-320 μm
Flight Speed (km/h) or (m/s)	22-25 km/h
Route Spacing (ft) or (m)	7.5-9 m
Height Above the Crop (m)	3-3.5 m
Total Operation Duration (mins or hours)	47 hours

Agricultural Drone Industry Insight Report

The drone's centrifugal nozzle ensured even distribution of chemicals across the field. The total operation duration was approximately 47 hours, with each drone operating for 15 hours per session.

The treated fields showed significant improvement compared to untreated controls. The benefits of using drones in corn operations are evident, including prompt post-rain activities, decreased water usage, cost-effectiveness, prevention of soil indentation, and simplified relocation between plots.

The use of drones in corn farming has proven to be a game-changer for Brazilian farmers. By addressing challenges more efficiently, improving crop yield, and reducing costs, drone technology is setting new standards for agricultural innovation.

In conclusion, the integration of drones into corn farming in Brazil showcases the immense potential of precision agriculture technology. By leveraging drones, farmers can achieve higher yields, reduce costs, and contribute to sustainable farming practices. If you're interested in exploring the benefits of drone technology for your farming operations, consider adopting DJI Agriculture drones and experience the transformation firsthand.

Best practice: Romania

The Riagro team[18], a well-known local spraying service, conducted a trial with support from FMC, the international chemical company, to test the effectiveness of Agras T50 in controlling the pest Helicoverpa armigera[19] in corn crops.

Chemical used	Chemical amount	% Field Affected Before Spraying	% Field Affected After Spraying	Efficacy
CORAGEN	150 ml/ha	90%	10%	88%

18.Special thanks the Riagro team, Ferma Codrea and Il Iovuta Ana Maria in Romania for their help with this solution article.
19.See: https://en.wikipedia.org/wiki/Helicoverpa_armigera

Trial Method: The team employed a standard formula used in the Romanian agriculture industry to quantify pest impact. This involves calculating the degree of pest attack by multiplying the percentage of affected plants by the attack intensity, then dividing by 100. The percentage of affected plants represents the number of plants impacted among those studied, and the attack intensity is graded from 0 to 6 based on the extent of plant damage.

Grade	The percentage in which the plant is affected
0	0%
1	1-3%
2	4-10%
3	11-25%
4	26-50%
5	51-75%
6	76-100%

The integration of DJI Agriculture drone solutions in corn farming represents a significant leap towards modern, efficient, and sustainable agriculture. By addressing the limitations of traditional methods, drones offer enhanced precision, cost-effectiveness, improved crop health, and environmental benefits.
For farmers looking to optimize their operations and increase yields, adopting drone technology is a strategic move. Explore the full potential of DJI Agriculture drone solutions and take your corn farming to the next level.

4.1.2 Growing Coffee in Brazil with Drones

Brazil has a rich history of coffee production that dates back to the 18th century. The country is the world's largest coffee producer, contributing to approximately one-third of the global coffee supply. The fertile soils and favorable climate conditions make it an ideal location for growing high-quality coffee beans. However, the industry has faced numerous challenges over the years, from pests and diseases to fluctuating market prices.

One of the most significant challenges in Brazilian coffee farming is pest infestations and diseases. Seedlings are susceptible to fungal diseases like damping-off and pests such as aphids. During the growth period, coffee trees are vulnerable to scale insects, leaf spot diseases, and aphids. The flowering and fruiting stages are particularly critical, as fruit borers and diseases like coffee rust can severely impact the yield.
The unpredictable weather patterns in Brazil also pose a challenge. Excessive rainfall can lead to fungal growth, while drought conditions can stress the plants, making them more susceptible to diseases and pests. These environmental factors necessitate effective and timely interventions to protect the crops.
Traditional methods of pest control and crop management often fall short in addressing these challenges. Manual spraying and tractor spraying have traditionally been the go-to techniques, but they come with their own set of shortcomings. Manual spraying is labor-intensive and poses health risks to workers. Tractor spraying can damage tree branches, reducing production by 5-10%.

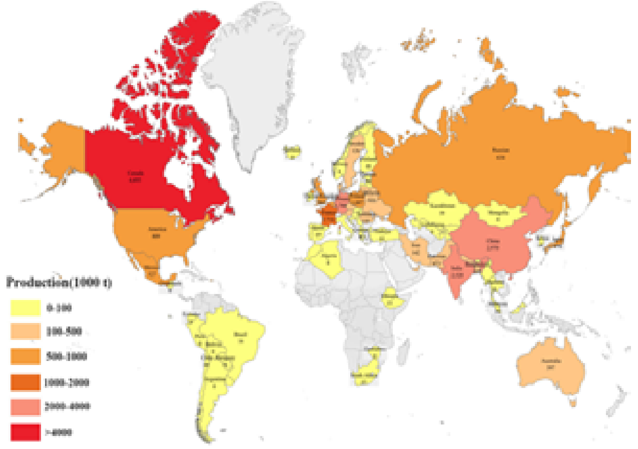
Drone technology has emerged as a game-changer in various agricultural practices, including coffee farming. Drones offer a more efficient, cost-effective, and safer alternative to traditional farming techniques. They can cover large areas quickly, apply treatments precisely, and minimize the risk to human health.
In 2024, the Brazilian coffee industry saw a significant shift with the introduction of the DJI Agras T40 and Agras T50 drones. These drones are equipped with advanced features like adjustable droplet size and terrain-following capabilities, making them ideal for the unique challenges posed by coffee farming.
The interventions involved the use of pesticides, fungicides, and foliar fertilizers. The precise application ensured minimal chemical usage while maximizing effectiveness.

Parameter	Value
Firmware Version	Latest version compatible with DJI Agras T50
Operation Mode	Automatic
Operation Speed	6-8 m/s
Operation Height	4.5 meters from the top of the crops
Route Spacing	7 meters
Liquid Amount Sprayed	8 liters per hectare
Nozzle Type	Centrifugal
Droplet Size	350 μm

The effects of the drone intervention were noticeable within days. The treated coffee plants showed significant improvement in health compared to untreated controls. The precise application of chemicals reduced waste and minimized environmental impact.
The use of drones brought numerous benefits:
• **Time Saved:** Reduced the time required for spraying operations.
• **Cost Savings:** 70% reduction in operational costs compared to manual spraying, and 50% reduction in costs compared to tractor spraying.
• **Increased Yield:** Healthier plants led to better yields.
• **Reduced Chemical Usage:** Precise application minimized chemical usage.
• **Enhanced Safety:** Reduced risk to human health.
Integrating drone technology into Brazilian coffee farming has elevated the industry, with DJI Agras T50 drones proving invaluable. These drones bring time and cost savings, increased yields, and enhanced safety. The use of DJI drones highlights the transformative potential of technology in agriculture, promoting better yields, reduced costs, and sustainability. By blending tradition with innovation, Brazilian coffee farmers set new standards in agricultural excellence.

4.1.3 Canola Farming with Drones

In the world of agriculture, canola stands out as a crop of tremendous global significance. Originally cultivated over 4,000 years ago in India, canola has emerged as the third-largest source of vegetable oil and the second-largest source of protein meal worldwide. Its importance extends to countries like China, Canada, and India, which are top producers, collectively yielding millions of tons annually. Despite its importance, canola farmers face substantial challenges using traditional farming methods, including inefficiencies, high labor costs, and potential safety risks. In this article we discuss how drones can help elevate canola farming efficiency and yields.

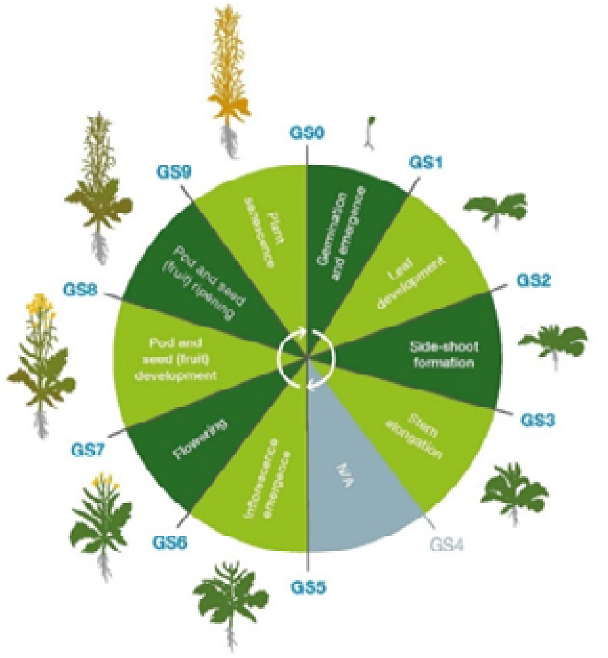


Traditional canola farming often leaves farmers struggling with inefficiencies and losses. The use of tractors and ground sprayers poses risks to crop integrity and incurs high operational costs. These methods also demand significant labor input and are challenged by adverse weather conditions. During wet conditions, tractors may struggle to operate, further delaying critical farming tasks and potentially impacting crop health.

In contrast, drones provide a nimble and efficient alternative, capable of addressing many of these pain points through advanced technology and precision application.

Drone technology in agriculture presents a suite of solutions to overcome these traditional challenges. For starters, agricultural drones can operate without damaging crops, as fly over the plants ensuring zero contact. This not only preserves the integrity of the crops but also increases potential yield by eliminating losses due to wheel track damage. Furthermore, drones significantly save on labor and fuel; they require only one to two operators and use less fuel than tractors. Additionally, drones conserve water by using precise spraying techniques, ultimately reducing chemical waste and promoting sustainable farming practices.

Throughout the canola life cycle, there are numerous occasions where drones can provide immense value. During the germination and leaf development stages, drones can apply pre- and post-emergence herbicides, effectively managing weed growth. Moving into the flowering and pod development stages, drones can administer fungicides and insecticides, ensuring plant health and optimizing growth conditions. At the ripening stage, drones can be used for the precise application of fertilizers, promoting robust crop development. This versatility demonstrates the critical role drones can play at every phase of canola farming.



Growth Stage Name	Type of Spraying
GS0 (Germination and emergence)	Pre-and post-emergence herbicide spraying
GS1 (Leaf development)	Pre-and post-emergence herbicide spraying
GS2 (Side-shoot formation)	Fungicide, insecticide, and foliar fertilizer spraying
GS3 (Stem elongation/ extension)	Fungicide, insecticide, and foliar fertilizer spraying
GS5 (Inflorescence/ flower-bud emergence)	Fungicide, insecticide, and foliar fertilizer spraying
GS6 (Flowering)	Fungicide, insecticide, and foliar fertilizer spraying
GS7 (Pod/seed (fruit) development)	Fungicide, insecticide, and foliar fertilizer spraying
GS8 (Pod/seed (fruit) ripening)	Fungicide, insecticide, and foliar fertilizer spraying
GS8 (Pod/seed (fruit) ripening)	Cover crop seeding
GS9 (Senescence)	Cover crop seeding

Best Practices for Canola Spraying with Drones

To maximize the benefits of drones in canola farming, it is essential to follow best practices. It's recommended to operate drones at a height of 3-3.2 meters above the crop with route spacing of 6-6.5 meters and a flight speed of 20-25 km/h for optimal results. Constant consultation with agronomists and adherence to chemical labels will further enhance these operations.

Parameter	DJI Agras T40/T50 (Herbicide)	DJI Agras T40/T50 (Insecticide/Fungicide/ Foliar Fertilizer)	DJI Agras T30 (Herbicide)	DJI Agras T30 (Insecticide/Fungicide/ Foliar Fertilizer)
Application Rate (L/ha)	15-25	10-20	15-25	10-20
Droplet Size (μm)	250-400	100-300	XR110015VS	XR11001VS
Flight Speed (km/h)	20-25	20-25	18-20	20-23
Route Spacing (m)	6-6.5	7-9	5.5-6	6-6.5
Height Above the Crop (m)	3-3.2	3-3.5	2.2-2.5	2.5-3

The use of spraying drones like the T50 prevents the 5.3% crop damage typically caused by tractors navigating between rows, thus saving yields. This can potentially increase crop output by 159-238 kg per hectare, translating to an income boost of €79-119 per hectare for farmers.

4.1.4 Sunflower Farming with Drone Technology

Imagine fields of sunflowers stretching as far as the eye can see. These vibrant yellow blossoms are more than just a feast for the eyes; they hold historical and economic significance. First domesticated in the Americas, sunflower seeds found their way to Europe in the 16th century. Today, Eastern Europe dominates the global production of sunflower seeds, contributing over half of the world's supply. In 2020, global sunflower seed production reached 50 million tonnes, highlighting the crop's importance and the need for effective farming solutions.

Agricultural Drone Industry Insight Report

Despite its importance, sunflower farming faces challenges, particularly in pest control and growth optimization. But with the introduction of DJI Agriculture drone solutions, these challenges are becoming a thing of the past. This solution guide dives into how sunflower farmers can harness the power of drones to enhance their crops, improve yield, and streamline operations.

Conventional farming equipment, like tractors and airplanes, has limitations. Tractors, while effective, can be dangerous for operators and struggle with uneven terrains.

Airplane cropduster services, on the other hand, require a minimum of 1000-1500 hectares to operate efficiently, causing delays in spraying and potential yield loss. Their high operational costs and environmental impact make them less than ideal for modern farming.

Traditional methods can also have negative environmental impacts. Droplet drift from airplanes poses risks to nearby crops, particularly when spraying desiccants or herbicides. This drift can lead to chemical contamination and environmental harm, affecting soil, air, and water resources.

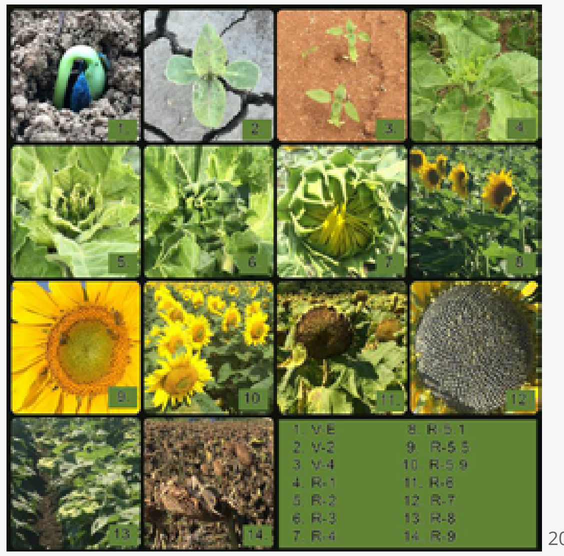
Traditional methods can be inefficient in terms of time and resources. Airplanes require specific take-off points, cannot spray at night, and often provide inadequate coverage, leading to lower yields and increased chemical use. Cropdusters are also unable to effectively cover fields with obstacles, slopes, or plots near boundaries, leading to bad coverage.

In contrast, DJI Agriculture drones offer a suite of benefits that address these challenges head-on.
DJI drones excel in navigating various terrains, including fields with slopes and obstacles. Their precision reduces droplet drift significantly, thanks to downwind flow from propellers and lower flight heights. This adaptability ensures thorough coverage, whether spraying desiccants or herbicides.
Drones speed up the harvest process. When using drones for desiccant spraying, farmers can harvest sunflowers 5-10 days earlier compared to airplanes. This acceleration ensures yields remain consistent and high, with a moisture content of 10-11% in sunflower seeds.
Drones are more cost-effective and environmentally friendly than traditional methods. By reducing chemical use by 25%, farmers save approximately $6 per hectare. Additionally, drones protect the environment by minimizing chemical drift and allowing spraying during optimal conditions, such as cooler nighttime temperatures.

Benefit of Drones:	Data or Examples:
Adaptable to different terrains	Radar and vision sensors allow for Terrain Following over slopes and hills
Limited droplet drift	Lower flight height and propeller downwash help minimize chemical drift
Faster harvest after spraying desiccant	Drone: Harvest in 10-15 days; Airplane: 20 days; Speeds up by 5-10 days
Lower moisture content in sunflower seeds	Drone: 10-11%; Airplane: 13-14%
Ensures a normal yield	Average yield of 3.1 ton/ha; Airplane yield generally 0.8-4 ton/ha
Saves on chemical use	Drone: 1.5 L/ha (SPORTAK) at $11.90 USD per liter; Airplane: 2 L/ha; Saves 6 USD/ha
Protects the environment	For 1000 ha, reduces chemical drift and uses 500 L less desiccant
Can spray at any time	Allows spraying during the day and at night for increased efficiency and efficacy
GS8 (Pod/seed (fruit) ripening)	Cover crop seeding
GS9 (Senescence)	Cover crop seeding

Drone Application Opportunities in Sunflower Farming

Utilizing DJI Agriculture drones unlocks a range of strategic opportunities for sunflower farmers throughout the crop's growth cycle.
Drones can be integrated into various stages of sunflower growth for improved productivity.



[20]

Pre-Emergent and Post-Emergent Herbicide Application

Before the V4 growth stage, drones can apply pre-emergent or post-emergent herbicides. This stage is crucial for controlling weeds and ensuring healthy crop development.

Fertilizer and Fungicide Spraying

Between the V4 and R8 growth stages, drones can apply foliar fertilizers, insecticides and fungicides. This targeted approach enhances nutrient uptake and prevents diseases like downy mildew and some insects.

Desiccant Spraying for Efficient Harvest

At the R9 stage, drones are ideal for desiccant spraying. Their precision ensures even application, leading to earlier harvests and better yield quality.

Best Practices for Drone Use in Sunflower Farming

To maximize the benefits of drone-assisted farming, adhere to best practices.
When using drones like the T40 or T50 for insecticide, fungicide, and foliar fertilizer spraying, set the application rate at 8-12 L/ha. Maintain a droplet size of 200-350μm, flight speed of 25-36 km/h, and route spacing of 8-9 meters. Keep the drone 3.5-4 meters above the crop.

Effective Desiccant Spraying Techniques

For desiccant applications, adjust the settings to 10-15 L/ha, with a droplet size of 100-300μm, flight speed of 21-28 km/h, and route spacing of 7-8 meters. Maintain the same height above the crop as with insecticide spraying.

Herbicide Spraying Recommendations

Herbicide spraying requires a coarser droplet size of 350-500μm to limit drift. Use an application rate of 10-15 L/ha, with a flight speed of 21-28 km/h and route spacing of 7-8 meters.

Insecticide & Fungicide & Foliar Fertilizer spraying

Drone Model	T40/T50
Application Rate (gal/acre) or (L/ha)	8-12 L/ha
Droplet Size (μm)	200-350 μm
Flight Speed (km/h)	25-36 km/h
Route Spacing(m)	8-9 m
Height Above the Crop(m)	3.5-4 m

20.https://nuseed.com/eu/sunflower-growth-stages/

Desiccant spraying

Drone Model	T40/T50
Application Rate (gal/acre) or (L/ha)	10-15 L/ha
Droplet Size (μm)	100-300 μm
Flight Speed (km/h)	21-28 km/h
Route Spacing(m)	7-8 m
Height Above the Crop(m)	3.5-4 m

Herbicide spraying

Drone Model	T40/T50
Application Rate (gal/acre) or (L/ha)	10-15 L/ha
Droplet Size (μm)	350-500 μm
Flight Speed (km/h)	21-28 km/h
Route Spacing(m)	7-8 m
Height Above the Crop(m)	3.5-4 m

*Notes: *1.Desiccants like Diquat is a kind of contact chemical, so generally the droplet size should be smaller so the coverage is better. However, watch out the wind speed and wind direction and crops nearby.*
2. The parameters including droplet size should be adjusted based on the temperature and humidity; if it is hot or the humidity is low, the application rate and droplet size could be greater.
3. The herbicide droplet size generally should be coarse to limit drifting and to protect the environment and crops nearby.
4. Do a test in a small area before a big area spraying. The parameters above are based on a case in Kazakhstan. You may need to change the application rate for local conditions.

In a decisive trial held in East Kazakhstan, Dizel Agro, a renowned local spraying service team, conducted a comparison of desiccation efficacy between the Agras T50 drone and traditional airplane methods over an area of 389 hectares. The primary objectives of this trial were to evaluate the potential reductions in chemical costs, lower seed moisture levels, and ultimately increase farmer income.
The results were impressive, with the drone's advanced capabilities yielding significant benefits. The powerful downwash effect from the drone's propellers ensured effective droplet penetration. In addition, its advanced radar system allowed it to adeptly navigate the slopes of the sunflower fields. This led to achieving a 3% reduction in seed moisture compared to the airplane method, while maintaining a similar gross weight.

This moisture reduction translated into an income increase of $11,830 for the farmer, calculated based on the sunflower yield of 3.1 tons per hectare at $327 per ton across the 389-hectare trial area. Moreover, the use of the T50 drone resulted in saving 0.5 liters per hectare of desiccant, amounting to an additional cost saving of $2,295, considering the chemical price of approximately $11.9 per liter. In total, the T50 application generated an additional $14,125 for the farmer.
Furthermore, the sunflowers treated with the Agras T50 were ready for harvest 10-15 days post-application, which is 5-10 days faster than the traditional airplane method that typically requires 20 days. This case study illustrates the potential for drones to enhance agricultural efficiency and profitability, delivering tangible economic advantages for farmers in East Kazakhstan.

After spraying desiccant with Agras T50

Conclusion

In the world of agriculture, staying ahead means adapting to new technologies. DJI Agriculture drone solutions offer sunflower farmers innovative ways to overcome traditional challenges, improve efficiency, and protect the environment. By following best practices, farmers can optimize sunflower growth and yield, securing a sustainable future for their crops. For those ready to take the next step, consider exploring DJI's range of drones to revolutionize your sunflower farming experience.

4.2 Spreading Application

4.2.1 Canola Seed Spreading

Canola seed, is a seed of the cruciferous crop canola. It is rich in oil and is one of China's main oil crops and honey-producing crops. As a long-day crop, canola is suitable for growing in cool or warm climates, and the entire growth period must be completed under an average daily temperature of less than 22°C. Canola cultivation is divided into winter canola and spring canola due to regional climate differences.

Canola Origin

Yangtze River Basin: The Yangtze River Basin is the main canola production area in China and the largest canola production belt in the world. The planting areas include Hubei, Hunan, Jiangxi, Anhui, Henan, Jiangsu, Zhejiang, Shanghai and other places. Among them, Hubei and Hunan have the highest canola production.

Southwest region: including Sichuan, Guizhou, Yunnan and other provinces, the annual planting area and output account for 20-30% of the country, among which Sichuan has become a major canola producing province in recent years.

Northwest region: It is the main producing area of spring canola in China, including Gansu, Qinghai, Shanxi, Inner Mongolia and other places. The canola planting area accounts for about 10% of the country.

Canola spreading time

Winter canola is generally spread from late September to late October, and the best spreading time is selected according to climatic conditions.

Agricultural drones are efficient and economical in spreading canola seeds, but the following points still need to be taken into consideration during operation to achieve the best results. The following will use winter canola as an example to explain.

Step 1: Seed and fertilizer preparation

1. Weeding and land preparation: After rice is harvested, the fields should be weeded immediately. 2-3 days after weeding, the fields should be mechanically plowed to a depth of 20-30 cm. After plowing, a rotary tiller should be used, and cross trenches should be opened in low-lying fields to facilitate drainage.

2. Confirmation of canola volume: The comprehensive canola volume is between 3750-7500 g/ha, 4500-7500 g/ha for paddy field, and 3750-7500 g/ha for dryland. If the spreading period is delayed, the spreading amount should be appropriately increased.

3. Seed coating treatment: It's recommended to use appropriate amounts of cypermethrin + carbofuran to mix the seeds to prevent insects and diseases.

Canola mixed with urea treatment

When using T40\T30\T20 models, it's recommended to manually set the size of the hatch to control the flow rate. The hatch should be controlled at about 10%-15%. Refer to the spreading amount to adjust the hatch size appropriately:
Before spreading, be sure to calibrate the spreading flow rate. Searching for the official teaching video in DJI Agricultural Service-DJI Academy. At the same time, due to differences in models, equipment aging, and differences in operating plots, it is recommended to test a flight for the first time to compare whether the per-acre usage is accurate, and adjust the per-acre usage parameters according to the deviation to ensure the actual operation effect.

Step 2: Setting the parameters of the T50&T25 seeding operation

Parameter/Model	T50/T25
Application Rate per Ha	15-30 kg or more
Height	3.5-4.5 meters
Speed	6-7 m/s
Rotation Speed	1000-1200 RPM
Row Spacing	4.5-5.5 meters
Hopper Opening	10%-15%

Plot retraction and edge sweeping settings: It is necessary to adjust the single-side retraction distance of the plot by 0.5m-1m according to the actual situation, and turn on automatic edge sweeping. If there are many obstacles at the edge of the plot, pilot could increase the retraction distance and manually sweep the edge to ensure that the canola at the edge of the plot is evenly covered.
As an important crop in China, canola has now developed into the fourth largest crop after rice, wheat and corn. At the same time, as the largest source of edible vegetable oil in in China, canola oil production accounts for more than 40% of domestic edible vegetable oil, and its status is pivotal. The Central Document No. 1 of 2024 clearly proposed to "expand the canola area" and "develop winter fallow fields in the Yangtze River Basin to expand canola planting", and made clear arrangements for the stable production and supply of "canola oil".
Compared with manual spreading, drone spreading saves time, effort and cost, greatly improving the efficiency of canola planting, and can complete hundreds of acres of spreading operations every day. The operation is carried out according to the preset route, per-acre usage and other indicator parameters, the spreading density is also uniform, and the spreading line is not missed or repeated. At the same time, drone spreading is not restricted by terrain and can better adapt to different terrains and scenes of canola spreading.
Drone spreading of canola seeds not only improves spreading efficiency and quality and reduces costs, but also helps to improve the mechanization and efficiency of canola spreading.
At present, many provinces in in China are stepping up the spreading of canola. Compared with manual spreading and transplanting, drone spreading has high efficiency, good uniformity and low cost, and is the choice of many farmers.

4.2.2 Rice Seed Spreading

The release of the MG-1S spreading system in 2018 marked a turning point in the capabilities of agriculture drones. Beyond just spraying pesticides and fungicides, drones are now used to spread rice seeds, granular fertilizers, and more, enhancing agricultural practices with their versatility.

DJI Agriculture drones have been transforming rice cultivation by offering farmers a more efficient and precise approach to spreading and fertilization. To achieve successful drone-based spreading operations, it is essential to follow several key steps and best practices for optimal results. Below is a comprehensive guide on using drones for rice seeding and fertilization.

The use of agriculture drones for rice spreading and fertilization offers many benefits compared to traditional methods. Some notable advantages include:

- Increased efficiency and speed, reducing labor
- Precise application, leading to reduced waste and damage to crops
- Accessibility to difficult or remote terrain
- Ability to cover larger areas in a shorter period of time
- Real-time monitoring and data collection for better decision making

To utilize the spreading system of your agricultural drone, begin by switching it to spreading mode. This process is quick and simply requires removing the spraying tank and installing the spreading tank.

Generally, there are some periods for rice growth and here is the main focus on each period of rice growth:

- Vegetative (tillering)
- Reproductive (flowering)
- ipening

To achieve optimal results in rice spreading and fertilization, it is important to understand the different growth periods of rice plants. This knowledge can help determine the appropriate timing for seeding and fertilization using agricultural drones.

a. Selecting the Right Spreading Time

Rice growth is significantly affected by seasonal and climatic conditions. Selecting the optimal planting time is crucial for successful cultivation. The ideal spreading period for rice seeds differs by region, so it is important to refer to local climate data or consult agricultural experts and agronomists when planning the planting schedule.

b. Pest and Disease Control

Rice crops are susceptible to numerous pests and diseases that can greatly affect both yield and quality. Conducting regular field inspections is crucial, and prompt control measures should be enacted upon detecting any infestations or infections. This proactive approach helps minimize losses and ensures the health of the crop.

c. Timely Fertilization

Proper nutrition is crucial throughout the various stages of rice growth. Apply nitrogen, phosphorus, and potassium fertilizers as required, taking care to avoid over-fertilization, which can result in soil pollution and environmental harm.

d. Efficient Field Management

Rice fields require effective management practices, including weeding, pruning, and supplementary fertilization. These activities help promote healthy growth, increase yield, and improve crop quality.

Preparation Before Drone Spreading and Fertilization

a. Ensure Flight Safety:

Before starting any drone operation, ensure that the flight environment is safe. Drones should avoid any risk to people, buildings, or other obstacles during flight.

b. Accurate Positioning and Flight Route Planning

Effective route planning is essential when using agricultural drones for spreading or fertilization. Proper route coverage ensures that every section of the field is covered, reducing the risk of gaps or overlapping coverage.

c. Appropriate Flight Parameters

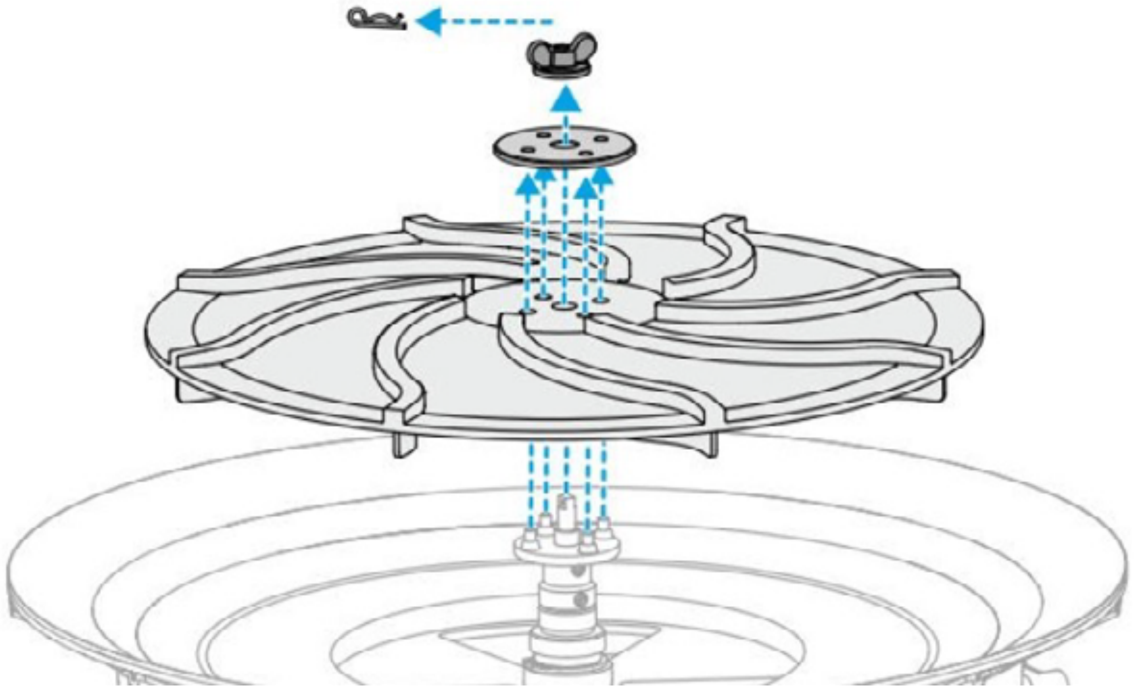
Adjust the drone's flight parameters such as altitude and speed based on crop height and field conditions. Lower altitudes generally improve spraying or spreading accuracy, but care should be taken to avoid colliding with crops or uneven terrain.

Here are parameters recommended for spreading rice seed:

Height Above Crop	4 - 5 m	Application Rate	140-200 kg/ha
Flight Speed	6 – 7 m/s	Route Spacing	4.5 - 5.5 m
Mode	(Auto)Route Mode	Spinner Speed	900-1100 rpm/min
Scenario	Route Mode+ Above water(if have water surface)	Hopper Gate	Standard
Obstacle Avoidance	Turn on	Wind Speed	Below 5 m/s
Low Speed Ascend	Turn on	Flight Optimization	Auto Route Spacing Adjustment –Turn on Smart Resume – Turn on

Drones and its spreading systems require regular maintenance to ensure operational efficiency and safety. Regular inspections of the spreading system, flight control systems, and batteries are essential to maintain accuracy and reliability.

Spreader Cleaning: After each use, remove and clean the spreader. A steam cleaner can be used to remove any stuck fertilizer or manure from the motor module and control board. Follow this by wiping it clean with a damp cloth and then drying it with a dry cloth.
Plastic Bin and Spreader Plate: Clean these components using a water hose and brush to remove any remaining material. Allow them to dry completely before storage.



Considerations with Agricultural Drones
Route Spacing Settings During Spreading: There's a fundamental principle: As a drone's flight altitude rises or its spreading disk speed increases, the row spacing may expand. Therefore, it's crucial to adjust route spacing appropriately to ensure even seed distribution. To prevent rice seeding overlap between routes, it is highly recommended to adhere to the aforementioned parameters.
Calibration for New Materials: When switching to a new material, such as a different seed type or fertilizer, create a new calibration template to ensure accurate application rate. Calibration should include loading the new material into the spreader and adjusting flow rates.
Flat Terrain Requirements: Fields for rice spreading should be level, with variations in height not exceeding 5 cm. Uneven fields may result in water pooling, hindering seed germination and emergence. It's recommended to use a tractor to level the field first and check if it's even or not.
Seed Pre-Germination: Pre-germinated rice seeds should have sprouts between 1-3 mm. Sprouts longer than 3 mm may cause blockages during spreading, leading to uneven distribution.

The seed sprouts shown here can be considered too long.

Low application rate: If you plan to apply a very low rate, between 5-25 kg/ha, consider switching from the standard hopper gate to a small one.[21]

Precautions for Fertilizer Spreading

Battery and Fertilizer Loading Order: When loading fertilizer, ensure the battery is inserted first. Dust that kicks up when pouring fertilizer can cause rusting of the metal battery connector, especially on the electrified distribution board.

Fertilizer Flight Parameters: The use of fertilizers is less strict than that of seed spreading, and the range of settings could be wider.

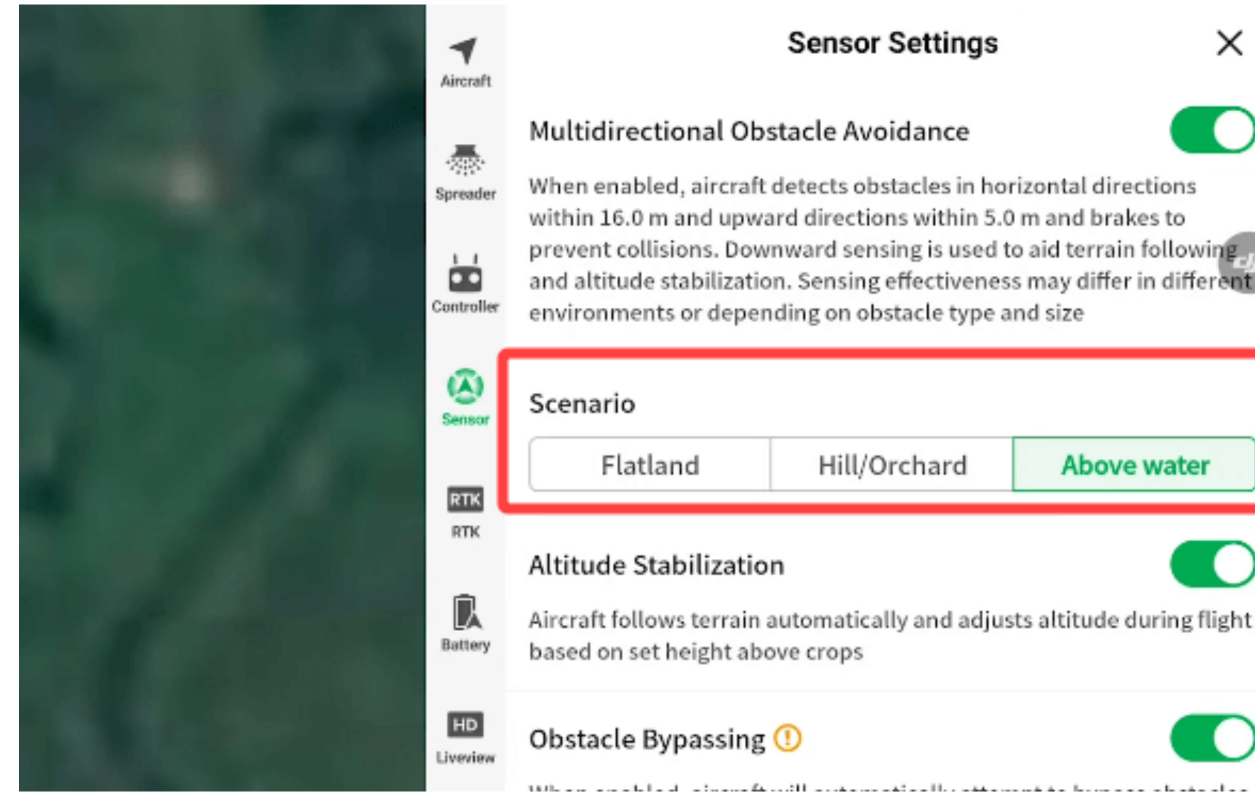
Here are recommended parameters for spreading fertilizer:

Height Above Crop	3 - 4 m	**Application Rate**	50 – 750 kg/ha
Flight Speed	6 – 7 m/s	**Route Spacing**	4 – 7 m
Mode	(Auto)Route Mode	**Spinner Speed**	700 – 1000 rpm/min
Scenario	Route Mode+ Above water (if have water surface)	**Hopper Gate**	Standard
Obstacle Avoidance	Turn on	**Wind Speed**	Below5m/s
Low Speed Ascend	Turn on	**Flight Optimization**	Auto Route Spacing Adjustment –Turn on Smart Resume – Turn on

21.Note: T50 & T25 have large (standard) and small (optional) hopper gates that can be swapped. T40 &T20P have large (standard), small (optional), and smallest (optional) that can be swapped.

Common Errors and Troubleshooting

Incorrect Flight Altitude: If the altitude is not suitable, especially in water-covered fields, use the “above water” setting for better control over operations.



Wide Row Spacing: The route spacing should not exceed 6 meters when spreading rice seeds due to their higher friction. Wider spacing may cause gaps, leading to uneven distribution.

Spreading Omission: If spreading errors occur due to internal shrinkage settings or a lag in shutter timing, check the germination status after 1-2 weeks and manually address any gaps. Updating to the latest firmware may also help prevent such issues.

Drone U-turns: When the drone goes beyond the field during U-turns, set a safety distance for better control at field edges.

Uneven Route Spacing: If the spacing on the left and right sides of the drone's route is inconsistent, set the route interval auto-adjustment to ON and update the route settings for balanced coverage.

By following these guidelines and best practices, the pilot could harness the full potential of agricultural drones, achieving higher productivity and more precise crop management, leading to greater yields and resource efficiency.

4.3 Orchard Management

4.3.1. Drone Application in Banana Cultivation

Bananas, a significant tropical fruit, are cultivated and enjoyed worldwide, predominantly in tropical and subtropical regions. Key growing regions include Latin America, with countries like Ecuador, Costa Rica, and Colombia; Asia, with the Philippines, Indonesia, India, and Vietnam; and Africa, with Tanzania and Angola leading the way. These regions offer the ideal climate for banana growth, but also attract pests and diseases, affecting yield and quality. Consequently, farmers have been exploring more efficient ways to safeguard the plants and enhance their yield and quality. The incorporation of drone technology into the banana industry has proven to be remarkably successful.
In tropical nations like Vietnam, the banana growth cycle is heavily influenced by the rainy season which constitutes half of its development period. This climatic condition often triggers substantial pest infestations. Ensuring short intervals without rain is crucial for timely application of fungicides and pesticides, an action that significantly affects banana yields. If pests are not addressed within this critical timeframe, there could be a drastic plunge in production.

Drones, particularly the T50 model, offer significant advantages in terms of efficiency for pest control measures. To put it into perspective, a single T50 drone can cover an area of 1.5 hectares within an hour, which equates to approximately 10 hectares in a day. This is a stark contrast to manual backpack spraying methods where two workers would need an entire day to treat just 1 hectare.

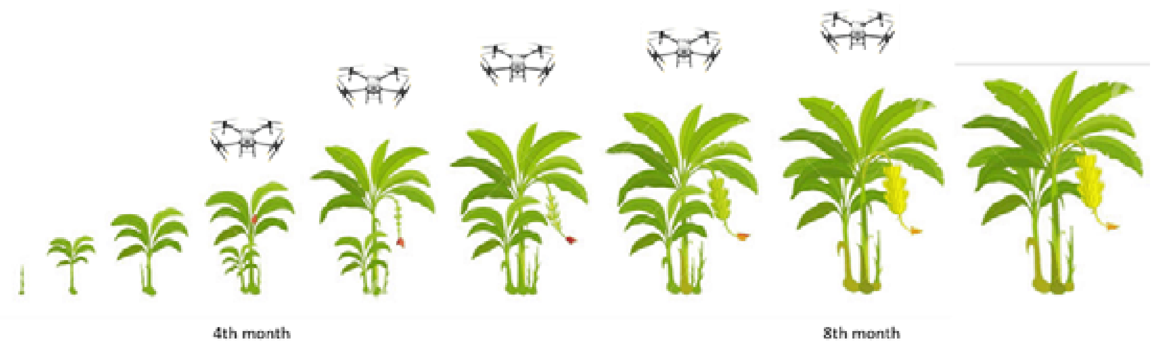
Drone-based spraying systems offer substantial benefits over traditional manual methods for applying fungicides and pesticides in banana farming. These drones employ atomized spraying technology, producing fine droplets that thoroughly coat banana leaves, thereby improving the absorption of these protective chemicals. Many banana farmers have noted that this method maintains effective operations even with less usage of fungicides and pesticides. User feedback indicates a considerable reduction in resources - water usage has dropped by 90% annually, and the application of fungicides and pesticides has decreased by 40%.

Thus, drone-based spraying not only boosts the effectiveness of crop protection measures but also contributes significantly to environmental preservation and water resource conservation.

Banana plants typically undergo a growth cycle lasting 9-12 months. For the initial three months, both manual spraying and drones are utilized for pest control. After this period, drones assume the responsibility of spraying. Using Vietnamese banana farms as an example, the growth cycle spans nine months. During this time, fungicides and pesticides need to be applied every 10-15 days, generally concluding in the ninth month, right before harvest. Crucially, throughout the growth cycle, it's essential to either proactively prevent or swiftly react to pest infestations detected during manual field inspections.

Overall, Drones play a vital role in all stages of banana cultivation. Particularly from the fourth to the eighth month, which is a critical period in banana farming, most farmers opt for drone usage due to its economic benefits and efficiency.

1st	2nd	3rd
Manual spraying(primary) Agras Drone spraying	Manual spraying(primary) Agras Drone spraying	Manual spraying(primary) Agras Drone spraying
4th	**5th**	**6th**
Agras Drone spraying(primary) Manual spraying	Agras Drone spraying(primary) Manual spraying	Agras Drone spraying(primary) Manual spraying
7th	**8th**	**9th**
Agras Drone spraying(primary)	Manual spraying(primary) Agras Drone spraying	Manual spraying(primary) Agras Drone spraying



Banana plants require attentive care to ensure healthy growth and prevent common issues such as Panama disease and withering. To prevent and control these diseases and pests, farmers typically spray fungicide/pesticide once every two weeks. Understanding the development stages, areas of impact, and effective spraying schedules is crucial for successful banana cultivation. Productivity increases as a result of higher bunch weights, which are achieved through an ample number of functional leaves during harvest.
The following are examples of using drones to spray chemicals for prevention and control.

1. Panama Disease
• Development Stage: From planting until 4 months old
• Affected Areas: Found on the ground and banana stem
• Spraying Schedule: In the first month, spray 1-2 times/month combined with moisturizing and water supply.
• Aircraft Efficiency: As it mainly affects the soil and plant body, thorough soil spraying initially and then some hand spraying on the body is sufficient. Agras drone spraying has significantly reduced the need for manual spraying from top to bottom.

2. Withering
• Development Stage: 4 months or more
• Affected Areas: Soft leaf buds, mainly on the leaves
• Spraying Schedule: Spray evenly twice a week
• Aircraft Efficiency: Spraying evenly from top to bottom covers the leaf surface effectively, eliminating the need for manual spraying.

By following these guidelines for panama disease and withering prevention, banana farmers can efficiently manage their plants' health and yield better harvests.
Also, remember to adapt these recommendations based on local climate and specific plant conditions for optimal results.
Vietnam is one of the world's major banana-producing countries. Previously, farmers relied more on manual backpack spraying for bananas, but the introduction of drone technology into banana cultivation has yielded significant results. Agras drones can replace manual labor to timely spray fungicide/pesticide during the banana growth cycle, usually spraying once every 10-15 days, 2-3 times a month.
Agras drone uses automatic flight routes: The pilot sets the following parameters, while ground assistant inserts the flight battery and add the chemicals. The Agras drone then carries out fully automated operations.

Parameters:

Model	T50	**Application rate**	200-250 L/ha
Speed	1-1. 5m/s	**Height**	3m

4.3.2 Transforming Vineyard Spraying with Drone Technology

Vineyard spraying in Romania is getting a futuristic upgrade, thanks to advanced drone technology. Imagine managing your vineyard with precision, efficiency, and sustainability—all made possible by the DJI Agras drones. This case study from Romania focuses on how vineyard owners are revolutionizing their spraying practices with drones. Whether you're an agricultural innovator, a modern farmer, or simply a tech enthusiast, this comprehensive guide will give you valuable insights into drone applications in viticulture.

Our case study focuses on a vineyard located in Romania, a country known for its rich viticultural heritage. The vineyard is situated on a slope, presenting unique challenges for traditional spraying methods. The region experiences a temperate climate, with average temperatures in July ranging from 21.5°C to 22°C.
Grapes are susceptible to various pests and diseases that can significantly affect yield and quality. Efficient spraying is essential for maintaining the health and productivity of the vineyard.
The challenges faced by vineyard owners in Romania are multifaceted. The sloped terrain makes it difficult to use traditional tractors for spraying, especially after rain. Additionally, the volume of water required for spraying is substantial, the challenge of which can be compounded when water sources are located far from the slopes. Time-consuming operations and the inability to spray at night further complicate matters.
The primary goal of introducing drone technology in this vineyard is to reduce pesticide consumption while maintaining or improving crop health and yield. Drones offer a solution that addresses both the efficiency and sustainability aspects of vineyard management.
Before the introduction of drones, vineyard owners relied on tractors for spraying. This method was not only time-consuming but also impractical for the sloped terrain and post-rain conditions.
Without drones, spraying the entire vineyard would take 3-4 days.
The cost of manual labor and water was significantly higher.
Traditional methods were impractical for nighttime operations and post-rain conditions.
Meet Vineyard Owner Vladimir
The end-user in this case study is Vladimir Potiuc, a 70-year-old vineyard owner and HORECA business owner. Vladimir is a tech-savvy individual who recognizes the advantages of modern technology. He learned about DJI Agriculture drones at a tradeshow where he met representatives from DJI Agriculture dealer Drone Box. This season, when encountering a critical period where he needed to spray his vineyards, Vladimir found he was unable to deploy his tractor because of the slopes softened from recent rains. He called Drone Box and took them up on their services.
Vladimir's vineyard ultimately relied on drones during the entire 2024 vineyard spraying season, where a DJI Agras T50 was used. This model was chosen for its advanced features, which were crucial for the operation's success.
The workflow with the DJI Agras drone was seamless and efficient, covering flight planning, data capture, analysis, and spraying.

Operation Parameters

	Drone Model T40/T50
Operation Mode (Automatic or Manual)	Automatic
Application Rate (L/ha)	50-90 L/ha
Droplet Size (μm)	70 – 250 μm
Flight Speed (km/h)	22 km/h
Route Spacing (m)	4 m
Height Above the Crop (m)	2.5-3 m
Total Operation Duration	2.5 hours
Total Operation Duration	2.5 hours

The drone intervention brought numerous benefits, significantly improving the vineyard's operations compared to untreated controls.

Benefit	Before Drones	After Drones
Chemical amount used per operation	241.64 liters or kg	111.84 liters or kg
Spray Time	3-4 days	2.5 hours
Cost on manual labor	320 EUR	80 EUR

Cost Reductions: Up to 70% in pesticide application costs.

Spray Time: Reduced from 3-4 days to 2.5 hours.

Chemical Usage: Substantially decreased, promoting sustainability.

The adoption of drone technology in vineyard spraying is transforming traditional farming practices in Romania. The DJI Agras T50 drone has proven to be a game-changer, offering efficiency, cost savings, and sustainability. For vineyard owners and agricultural innovators, integrating drones into their operations is no longer a luxury but a necessity.

Explore the future of viticulture with drone technology and take your vineyard management to the next level. For more insights and personalized advice, consider reaching out to our experts and see how drones can revolutionize your farming practices.

V. Best Practices

The use of agricultural drones is a multi-directional combination of personnel technology, product technology development, agronomy, agricultural technology, and pesticide application. This is inseparable from the joint efforts of the entire industry and the continuous exploration of the formation of "best practices".

5.1 Personnel Training

In 2024, DJI conducted team and content integration in training to provide more advanced training for partners combined with crop solutions, including pre-sales training for sales staff, delivery engineer training for technical personnel, so that partners can get a full range of product and industry education and promotion, so as to better serve the industry and users.

5.2 Technology Development

The DJI Agras T50 is a flagship of efficiency and stability, born from a deep understanding of the demands of large-scale farming. It inherits a coaxial dual-rotor design and 54-inch propellers for next-level stability when carrying 40 kg spraying or 50 kg spreading payloads, which enables efficient spraying of up to 50 acres (21 hectares) per hour[22]. T50's dual atomization spraying system, with an increased flow rate of up to 16 liters per minute with two sprinklers and adjustable-sized spray droplets, is ideal for a variety of applications from fields to orchards. Easily converted to its spreading configuration, the T50 can carry 50 kg of dry granules and spread at a flow rate of up to 108 kg/min[23] or 1.5 tones per hour. This combination of power, precision, and versatility sets T50 apart as a top choice in agricultural drones, designed to meet the evolving needs of modern farming.

22.Data was measured with the DJI AGRAS T50 and may vary based on operating environment and parameters. Flight parameters for this test: Dosage of 15 L/ha, spraying width of 11 m, flight speed of 7 m/s, and height of 3 m.
23.Data measured with 4 mm diameter urea. Max flow rate may vary depending on the granule size, density, and surface smoothness of different fertilizers.

5.2.1 Firmware Updates Support More Functions

From 2024 to 2025, the firmware updated several times. Here's a summary of the new functions and technologies introduced in the Agras T50/T25 firmware in different mode:

a. Route Operation Mode:
1)Displays the empty tank point on the map for multiple tasks.
2)Allows setting a maximum field margin up to 100 m (333 ft).
3)Shows nearby fields in the app for easier planning.
4)Adds mark lines and points for obstacles (e.g., power lines, water piles).
5)Introduces Low Speed Ascent in Flatland terrain to reduce crop lodging.
6)Introduces Sided Spraying to disable sprinklers on one side near obstacles or field edges.
7)Adds Low Speed Ascend with customizable altitude to minimize crop lodging.
8)Enables Multitask for automatic continuous operation in small fields.
9) ntroduces Sided Spraying to disable sprinklers on one side near obstacles or field edges.
10)Adds Low Speed Ascend with customizable altitude to minimize crop lodging.
11)Enables Multitask for automatic continuous operation in small fields.

b.Fruit Tree Operation Mode:
1)Adds an automatic spray/spread switch for route spacing, including during turns.
2)Supports spreading at fixed-spot routes.
3)Allows disabling atomized spraying.
4)Supports spreading on 3D flight routes for orchard automation.
5)Adds Targeted route type.
6)Allows waypoint location and altitude adjustments on 3D routes.
7)Operation Efficiency and Safety:
8)Predicts empty tank points in fruit tree operations.
9)Uploads parameter and spreading templates to the cloud.
10)Manually sets remaining liquid amounts if the meter fails.
11)Disables spinner disc during spraying.
12)Adds Frame Arm Lock-in Detection to prevent takeoff if arms are unsecured.

c.Manual Operation Mode:
Saves completed routes as fields in the task summary.
Adds Route Visualization in Manual Plus (M+) mode for even spraying.

5.2.2 Firmware Updates with more Safety Enhancements

Comprehensive flight safety features allow users to focus more on spraying during the operation by enabling the drone to utilize automatic takeoff, landing, and flight functions. Additionally, a new emergency braking mechanism is provided to assist in halting the drone swiftly in critical situations.
1)Improves subject confirmation for safer takeoff and landing.
2)Prevents takeoff during refilling.
3)Adds flight pause button functionality.
4)Optimizes Emergency Propeller Stop (C1, C2, and pause button combo).
5)Speeds up propeller stopping after landing.
6)Warns of abnormal propellers.

5.3 Combination of Agronomy and Technology

Agricultural drones have significantly transformed orchard management by introducing innovative techniques tailored to optimize drone operations. Here are the key changes they have brought to fruit tree cultivation:

Row and Plant Spacing: Orchards are now designed with narrower row spacing and adjusted plant distances to accommodate drone navigation and spraying efficiency. This ensures better coverage and minimizes obstacles during flight.

Canopy Management: Tree canopies are pruned to maintain a uniform shape and height, making it easier for drones to spray evenly and reach all parts of the tree.

Labor and Cost Efficiency: Drones reduce the need for manual labor in spraying and monitoring, lowering operational costs and improving efficiency. Automated flight paths and scheduling allow for consistent and frequent orchard management.

Adaptation of Tree Training Systems: Trees are trained into specific shapes to facilitate drone access and ensure optimal spray penetration.

Accessibility in Challenging Terrain: Drones can easily operate in steep or uneven terrains, ensuring comprehensive orchard care in areas that are difficult to access manually.
In summary, agricultural drones have reshaped orchard management by optimizing tree spacing, canopy structure, and spraying techniques, while also enhancing monitoring, efficiency, and sustainability. These changes have made drone operations more effective and aligned with modern precision agriculture practices.

VI. Epilogue

Agricultural drones, as a manifestation of cutting-edge technology and innovative productivity, have breathed new life into the millennia-old practice of agriculture. The evolution of the agricultural drone industry not only reflects humanity's aspiration for a healthier and more sustainable future but also embodies a steadfast dedication to the advancement of farming practices.

As we step into the new year, we envision the agricultural drone industry continuing to unite in its mission to enhance production efficiency, safeguard the ecological environment, and ultimately make agriculture more accessible and life more fulfilling. Together, let us strive to cultivate a future where innovation and sustainability go hand in hand.

AGRICULTURE

BETTER GROWTH, BETTER LIFE