

# Feasibility Study on Battery Operated and Hybrid Agriculture Drone

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# Parameters that affect deposition efficacy

## 1. Height and Speed:

The height and speed are fundamental parameters that affect the efficiency of spray. Finding the right balance between these parameters is necessary. Spraying is generally performed at height 1.0 m - 4.0 m and at speed of 1.0 m/s to 7.0 m/s.

## 2. Droplet Size:

Droplet size is important because coarse droplets do not penetrate and very fine droplet are prone to drift.

Size	VMD* Range (micron)
Extremely Fine	<60
Very Fine	61-105
Fine	106-235
Medium	236-340
Coarse	341-403
Very Coarse	404-502
Extremely Coarse	503-665
Ultra Coarse	>665

\*Volume Median Diameter



# Parameters that affect deposition efficacy contd..

## 3. Coefficient of Variance:

The uniformity of the spray droplet distribution on targets is commonly described by the CV of droplet density. The smaller the CV, the better is the uniformity.

Working Height	Sampling site	Droplet Density	Max	Min	SD	CV%
1.5 m	Upper	2.01f	6.2	0.7	2.35	117.1
	Middle	7.23d	30.2	0.77	12.88	178.1
	Lower	3.21e	6.4	0.73	2.76	85.8
2.0 m	Upper	11.35a	26.13	2.23	9.01	79.4
	Middle	9.35b	16.37	3.4	4.7	50.3
	Lower	9.17c	32.97	0.57	13.42	146.4



## 4. Application Rate:

Application Rate plays important role in describing the control efficiency of overall spray. It is a combination of multiple factors nozzle output, flight speed, and spray height above the crop canopy and hence influencing the spray swath.

# Data from Various Researcher's Studies

**Figure 1.** Freedom Eagle 1s Unmanned Aerial Vehicle (UAV).

**Table 1.** UAV technical parameters.

Classification	Parameters
Total Weight (kg)	12 ± 1
Size (m)	1.37*1.37*0.65
Battery capacity (mA)	16,000*2
Working efficiency (ha)	0.7–1.0
Runtime (min)	≥10
Operation method	Remote Control or Mobile
Boom length (cm)	90.5
height above crop canopy (m)	1–3
Number of nozzles	4
Unit flow (L/min)	1.92–2.36
Load capacity (L)	10
Spraying width (m)	3–5

Crop: Rice

**Table 1** Description of the treatments

Treatment	Equipment*	Nozzle	Speed /km·h <sup>-1</sup>	Application rate /L·hm <sup>-2</sup>
1	UAV	Flat fan XR 11001	21.8	10
2	UAV	Flat fan XR 11001	15.4	10
3	CO <sub>2</sub>	Flat fan XR 110015	5.0	115

Note: \*UAV: unmanned aerial vehicle, CO<sub>2</sub>: constant pressure backpack sprayer.

**Table 2** Description of the application equipment

Equipment*	Model	Nozzle number	Height application /m	Deposition swath /m
UAV	Agras MG-1	4	2.0	5.0
CO <sub>2</sub>	Research Herbicat	4	0.5	2.0

Note: \*UAV: unmanned aerial vehicle, CO<sub>2</sub>: constant pressure backpack sprayer.

Crop: Soyabean

# Complied Data from Various Researcher's Studies

Parameters for Operation of Drone on Various Crops

Crop	UAV	Flight Ht	Appl Rate	Flight Speed	Flow Rate Nozzle	Sray Swath	Time Required	Tank Capacity	Battery Capacity	No. of nozzles	References
		(m)	(L/ha)	(m/s)	(L/min)	(m)	(min)	(L)	(mAh)		
Rice	4 Rotor	2	18	3	0.65	4	15-20	10	12000	4	Wang et al
		1.5	15	5	1.58	3.5	t>10	10	16000*2	4	Lan et al
Wheat	6 Rotor	1	10	3.8	1.24	4	15-20	5	12000	2	Wang et al
Pepper	Dji T16	2	15	-	2.2-2.4	5	10 (20)	16	17500	8	Xiao et al
Grapes	Rmax Helicopter	3-4	47	5.5	-	4.8	N/A	16	N/A	-	Giles et al
Soyabean	Dji Mg1	2	10	6	-	5	15	10	12000	4	Juao Paulo et al
				4.2	-						
Cotton	P20	2	12	1-8	0.2-0.8	1.5-3	10-13	16	12000		Lou et al
Pineapple	Helicopter	2.5	-	3	0.8	5-8	N/A	12	N/A	2	J Wang et al
Groundnut	6 Rotor	1	55.15	1	-	5	16	5	8000	4	Yallapa et al
Sugarcane	4 Rotor	3	15	4	1	0-5	-	-	-	-	Maski et al
Citrus	DJI T30	1.6-2	75	3	0.25-0.45	4-5	8(20)	30	29000	16	Meng et al
Orchards	DJI Matrice 600	1.5	93.6	1.34	-	6	8-10	13.2	-		Xuan Li et al

[Link of References](#)

# Time Calculation based on Application Rate per Acre

- Time required per Acre:

$$L = 3\text{m}, W = 4\text{m} \text{ Time/s} = 4047/12 = 337.25$$

$$\text{Time/min} = 337.25/60 = 5.62 \text{ min}$$


Note: Endurance Flight Time of Drone is 12- 15 mins based on Battery Capacity

Time required to empty 10 lit tank :

$$\text{Time/s} = (5620.8 /12) = 468.4$$

$$\text{Time/min} = 468.4 /60 \sim 8 \text{ min}$$


Crop	UAV	Appl Rate	Flight Speed	Spray Swath	Time Req/ acre	Time req empty 10 lit
		(L/acre)	(m/s)	(m)	(min)	(min)
Rice	4 rotor	7.2	3	4	6	8
Wheat	6 rotor	4	3.8	4	5	11
Pepper	6 rotor	6	3	5	5	8
Grapes	Rmax Helicopter	18.8	5.5	4.8	3	2
Soyabean	6 rotor	4	4.2	5	4	8
Cotton	4 rotor	4.8	3	3	8	15
Groundnut	6 rotor	22.2	1	5	14	6
Sugarcane	4 rotor	6	4	4	5	7
Citrus	6 rotor	30	3	4	6	2
Orchards	6 rotor	37.44	1.34	6	8.5	2




**PM-DRONE**  
DRIVING TOWARDS NATION BUILDING THROUGH ADVANCE TECHNOLOGY

**AGRICULTURE  
SPRAYING DRONE**


### Features of MD-10H




Upto 6 acres/ hour




12 min Endurance with full payload




30 mins to charge the battery




Working voltage = 50.4 V




Foldable design



Max flying speed = 10 m/s



Max takeoff weight



Transmission range

Structure	Hexacopter structure, more stable and reliable, FOS=3.
Flight Modes	Fully Autonomous, Semi-autonomous and Loiter mode
Return to Launch (RTL)	Empty Tank, Battery drained, Mission Complete
Spraying Capacity	Up to 8 acres/Hour
Battery fly time	Up to 20 minutes with payload
Spray in 20 minutes	1 hectare (2.5 acres)
Spray capacity per day (8 hours)	30 Acres with multiple battery sets
Flying Range of GCS	Flies up to 5 Km (LOS) using Ground Control Station
RADAR based collision avoidance	Detects Tree, Poles, Wires etc in Autonomous Mode (22 meter) & re-route the path.

	Flight Parameters
Takeoff Weight (no load)	20.5kgs (with battery)
Takeoff Weight (full load)	37kgs
Battery	Lipo 12S-22000mAh
Data Transfer Range	5km
Flight Altitude	120m (relative height)
	Flight Speed
Spray Area	16-20acres
Spray Time	8-12min
	Tank
Tank Capacity	Rated 16L Max 16.5L
Tank Weight	1.5kg
	Spray System
Pressure Nozzle	Dual Nozzle
Model	VP11002
Pump Flow	3.5L/min
Working Voltage	44.4v
Spray Span	4-6m
	Camera and Searchlight

ITEM MODEL	E610 6 AXIS 10 L DRONE
WHEELBASE	1400MM
FOLDING SIZE	880*820*500MM
TANK CAPACITY	10L
SPRAY WIDTH	3-5M
WEIGHT	10KG
MAX TAKEOFF WEIGHT	26KG
FLIGHT TIME	8-10MIN WITH 16000 12-14MIN WITH 22000
HEIGHT	800M
RANGE	2KM

स्कायकिपर-एक्स २	
स्पेसिफिकेशन्स	
उड़ान कालावधि :	१२ मिनिटे
अंतर (LoS) :	१ किमी
वजन :	२४ किलोग्रॅम
वायू प्रतिरोध :	५ मीटर/सेकंद
कार्यरत उंची :	१ - १० मीटर जमीन पातळीच्या वर
व्हील बेस :	११०० एम एम
एकरी अंदाजे फवारणी कालावधि :	१० मिनिटांपेक्षा कमी
फवारणी क्षमता :	१० लीटर



# Salient Points of Battery Drones

- The cost of these drones is less compared to hybrid drones.
- Maintenance of these drones is very low.
- Safety offered is much higher.
- Limited pesticide carrying capacity.
- Limited flight time and range of operation.
- Not suitable where commercial application where area > 5 acres.





# Salient Points of Hybrid Drones

- Long range is offered by these drone.
- Pesticide carrying capacity of these is much higher.
- High cost and high maintenance.
- Technical team will required for proper maintenance.
- Safety issues is major problem if not maintained properly drone may burst.
- Since there are less suppliers of these drone spare parts availability will be an issue.



# Summary of Drones

In general there are two types of drone:

- **Battery Operated Drone:**

As the name suggest these drone uses batteries to fly and have carrying capacities of 10 lit and 16 lit and have average flight time of 10 to 15 mins. These drones covers area 2 to 2.5 acres with application rate varying from 1 to 3.5 lit/min. The battery life of these drone is 300 cycles.

- **Hybrid or Gasoline Operated Drones:**

Hybrid drone uses combination of petrol engine + battery or only uses petrol and converts it into electricity for flying. These drones have carrying capacities of 16lit, 20lit and 22lit and have average flight time of 35 to 40 mins. These drones can covers area 12 to 14 acres with application rate varying from 1 to 3.5 lit/min

*Thank You*