



干旱/半干旱地区的先进农业机械中数字和智能技术的应用 ——大载荷植保无人机高效施药技术及装备应用

**Digital and Intelligent Technologies in Advancing Agricultural Mechanization
in Arid and Semi-arid Areas**

**——The Efficient Spraying Technology of Large Load Plant Protection UAV and
Equipment Application**

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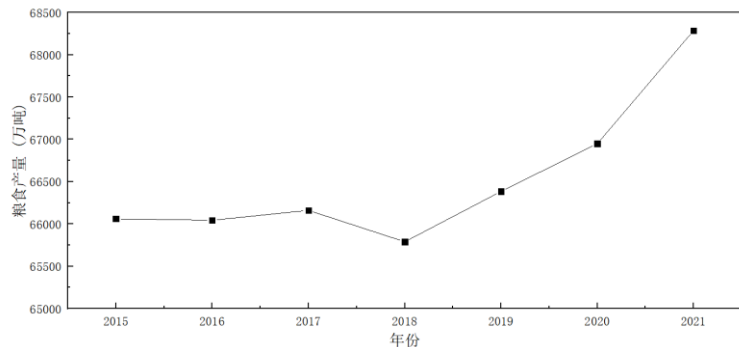
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大载荷植保无人机工程应用

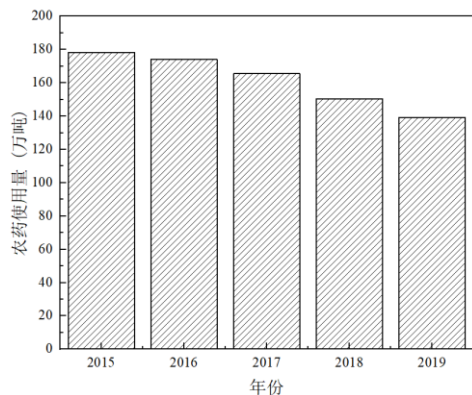
Engineering application of large load plant protection UAV



► 背景 Background

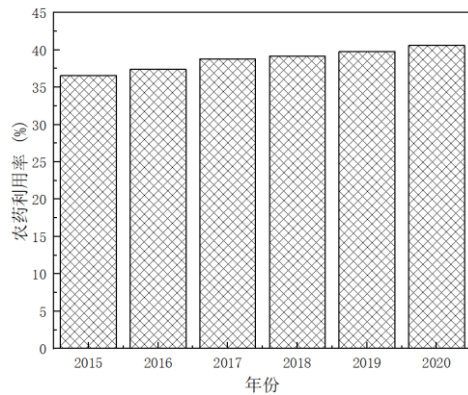


中国近年粮食产量
China's grain production in recent years



中国近年农药使用量

Pesticide usage in China in recent years



中国近年农药利用率

Pesticide utilization rate in China in recent years

- ◆ 中国每年粮食产量超过**65000**万吨；
China produces more **than 65,000 million tons** of grain per year
- ◆ 每年病虫害造成的损失**10%**以上；
More than 10% of annual losses due to pests and diseases.
- ◆ 2019年中国农药使用量**139.17**万吨；
In 2019, China's pesticide use is **1,391,700 tons**
- ◆ 2020年中国农药利用率为**40.6%**；
In 2020, China's pesticide utilization rate reaches **40.6%**.

数据来源:

Data sources:

[1] 国家统计局

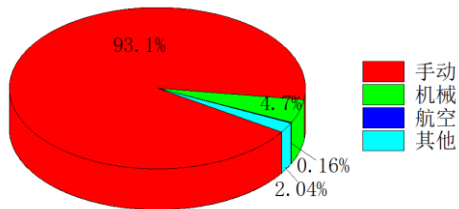
[1] National Bureau of Statistics

[2] 中华人民共和国农业农村部

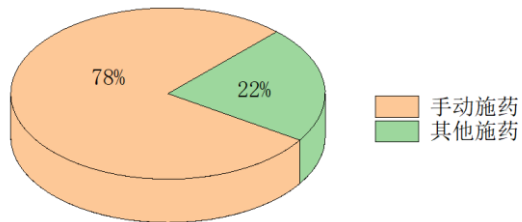
[2] Ministry of Agriculture and Rural Affairs of the People's Republic of China



➤ 背景 Background



中国植保器械种类
Types of plant protection equipment in China



中国农作物机械化病虫害防治面积
Mechanized crop pest and disease control area in China

目前中国主要采用**手动施药**机械完成农作物病虫害防治。
At present, China mainly uses manual spraying machinery to complete crop pest and disease control.



背负式施药机械
Backpack spraying machinery



悬挂式施药机械
Suspension application machinery

数据来源:

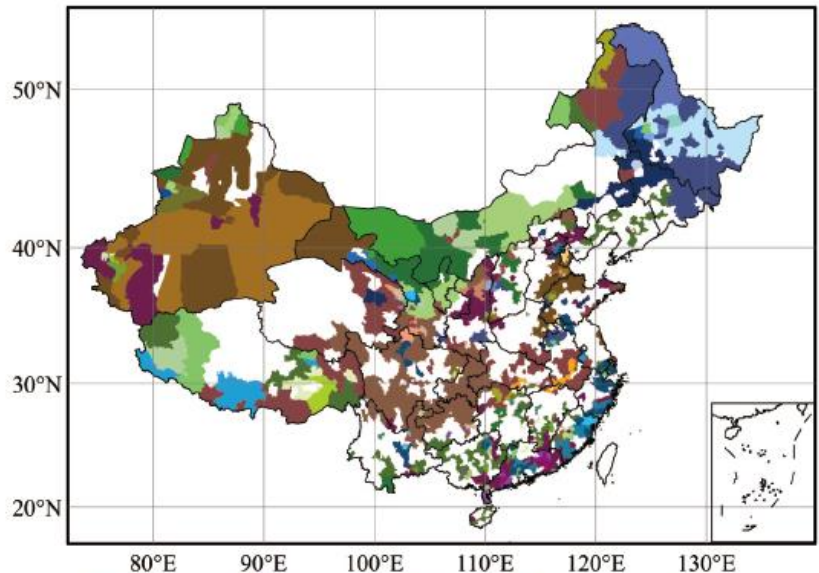
Data sources:

- [1] 全国农业技术推广服务中心
- [1] National Agricultural Technology Extension Service Center
- [2] 于俊萍. 国内外植保机械的发展与应用[J]. 山东农机化, 2020(06):28-31.
- [2] YU. The development and application of plant protection machinery at home and abroad [J]. Shandong Agricultural Mechanization, 2020(06):28-31.

➤ 背景 Background

我国国土面积广阔、地形复杂和种植模式多样化，**农业航空**是我国农业现代化发展的重要需求。

With China's vast land area, complex terrain and diversified planting patterns, agricultural aviation is an important need for the modernization and development of China's agriculture.



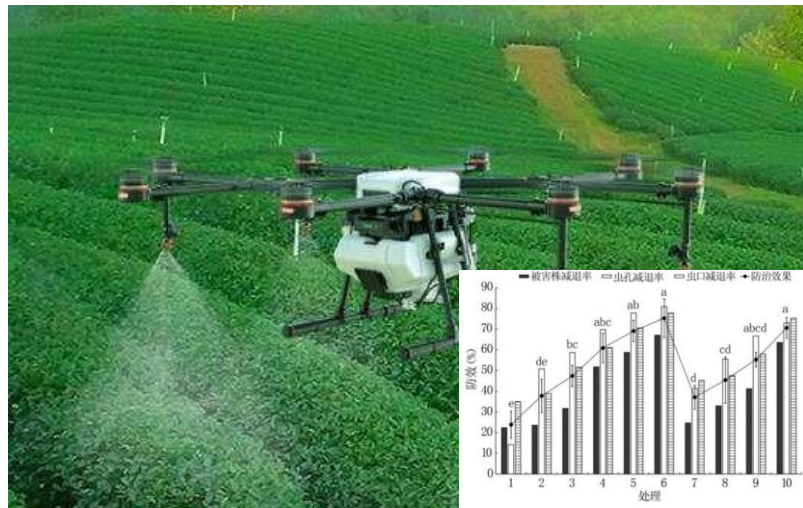
水稻	小麦	麻类	玉米	棉花
水稻/麻类	小麦/水果	麻类/油料	玉米/棉花	棉花/水果
水稻/玉米	小麦/玉米/水果	麻类/薯类	玉米/棉花/水果	棉花/油料
水稻/玉米/棉花	小麦/油料	水果	玉米/麻类	棉花/蔬菜
水稻/玉米/大豆	小麦/薯类	水果/糖料	玉米/水果	玉米/油料
水稻/油料	小麦/薯类/水果	蔬菜	薯类	玉米/薯类
水稻/大豆	小麦/薯类/水果	蔬菜/水果	薯类/水果	玉米/薯类/糖料
水稻/大豆/麻类	小麦/糖料	蔬菜/油料	薯类/油料	玉米/大豆
大豆	小麦/蔬菜	蔬菜/薯类	薯类/糖料	玉米/大豆/棉花
大豆/麻类	小麦/蔬菜/水果	蔬菜/糖料	薯类/糖料/油料	玉米/蔬菜/薯类
大豆/水果	小麦/蔬菜/油料	糖料	薯类/糖料/油料	麻类
大豆/薯类/水果	小麦/蔬菜/糖料	糖料/油料		

中国主要农作物产区分布

Distribution of major crop production areas in China



➤ 植保无人机简介 Brief Introduction of plant protection UAV



小载荷无人机的应用
Application of small load UAV

植保无人机:用于农林植物保护作业的无人驾驶飞机,由飞行平台(固定翼、直升机、多轴飞行器)、导航飞控、喷洒机构三部分组成。

Plant protection UAV: UAVs used in agriculture and forestry plant protection operations, consisting of a flight platform (fixed-wing, helicopter, multi-axis vehicle), navigation and flight control, and spraying mechanism.

➤ 植保无人机简介 Brief Introduction of plant protection UAV

				
对比项 Contrast items	FR-200	农鹰4d1000	水星一号	3WDM8-20
起飞载荷/ (kg) Take-off load/(kg)	200	25	45	38
有效载荷/ (kg) Payload/(kg)	80	10	20	20
单次作业量/ (亩) Single operation area /(mu)	> 100	18	40	20
喷幅/ (m) spray range /(m)	8-12	4-6	6	8-10
抗风能力 Wind resistance	强	弱	弱	弱

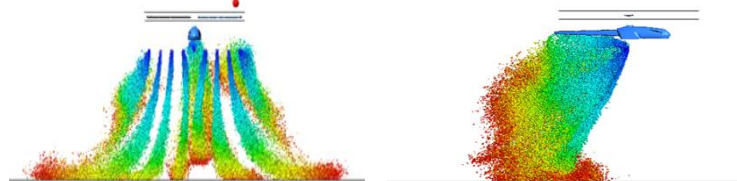
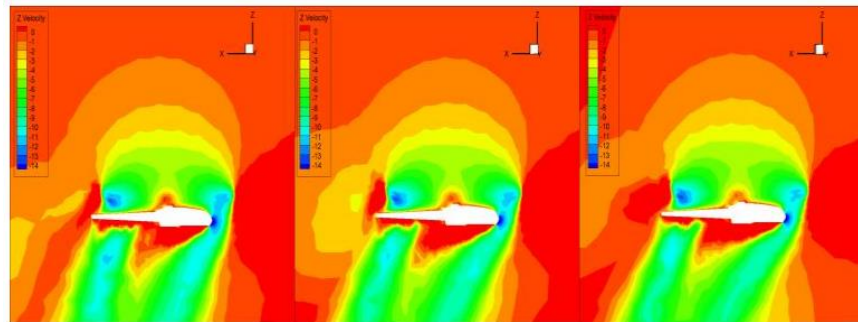
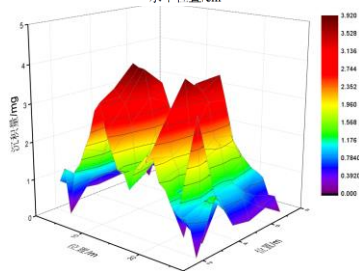
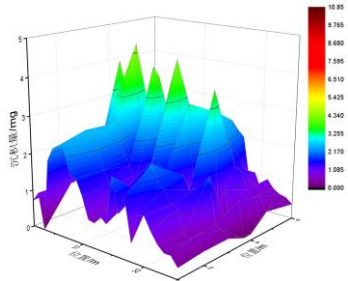
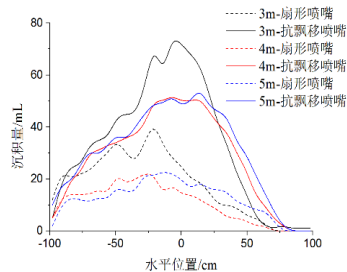
与小载荷无人机相比，大载荷无人机**载重量大、单次起降作业面积大、喷幅大、抗自然风能力强**，适用于干旱/半干旱等地区大规模农业生产经营。

Compared with small load UAV, large load UAV have **large load capacity, large single takeoff and landing operation area, large spraying area and strong resistance to natural wind**, which are suitable for large load agricultural production and operation in arid/semi-arid areas.



➤ 大载荷植保无人机喷洒技术

Large load plant protection UAV spraying technology



无人机旋机翼下洗气流对雾滴沉积影响实验研究

Experiment study of the effect of UAV rotor sweep airflow on the droplet deposition distribution

无人机旋机翼下洗气流对雾滴沉积影响数值模拟研究

Numerical simulation study of the effect of UAV rotor sweep airflow on the droplet deposition distribution

以大载荷无人机为飞行平台结合喷雾技术，实现农药在大载荷无人机下的喷洒。

A large load UAV was used as a flight platform combined with spraying technology to realize pesticide spraying under a large load UAV.

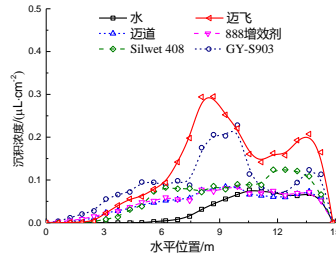
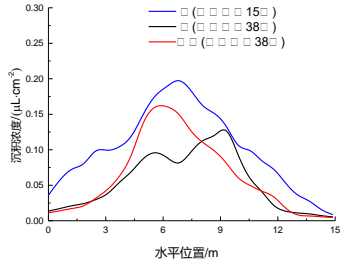
究表明大载荷无人机旋翼下洗气流对雾滴沉积分布的影响较大。

The study shows that the UAV rotor sweep airflow has a greater impact on the droplet deposition distribution.



大载荷植保无人机喷洒技术

Large load plant protection UAV spraying technology



实验研究表明采用助剂将雾滴分布均匀性提高**25%**，雾滴飘失率减小**11.4%**。

The experimental study showed that the use of additives increased the droplet distribution uniformity by **25%** and reduced the droplet loss rate by **11.4%**.

表1 雾滴分布对比

Tab.2 Comparison of droplet distribution

Type of drug solution	Average deposition /($\mu\text{L}/\text{cm}^2$)	Droplet distribution Uniformity/%
水(Water)	0.121	79.1
迈道(Maidao)	0.128	65.1
迈飞(Maifei)	0.210	59.3
Silwet 408	0.116	50.0
GY-S903	0.141	41.9
888增效剂 (Synergist 888)	0.165	52.1

表2 雾滴飘失率对比

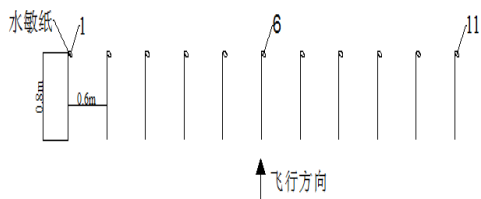
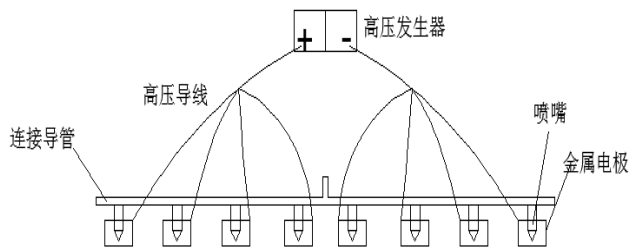
Tab.2 Comparison of droplet loss rate

Type of additives	Average speed of side wind /(m/s)	Average deposition /($\mu\text{L}/\text{cm}^2$)	Droplet drift center distance/m	Droplet loss rate/%
水(Water)	3.5	0.032	3.846	91.4
迈道(Maidao)	2.2	0.050	1.943	86.5
888增效剂 (Synergist 888)	3.4	0.106	1.749	71.4
Silwet 408	2.9	0.051	1.840	86.2
GY-S903	3.1	0.063	2.443	82.9
迈飞(Maifei)	4.0	0.120	2.218	67.6

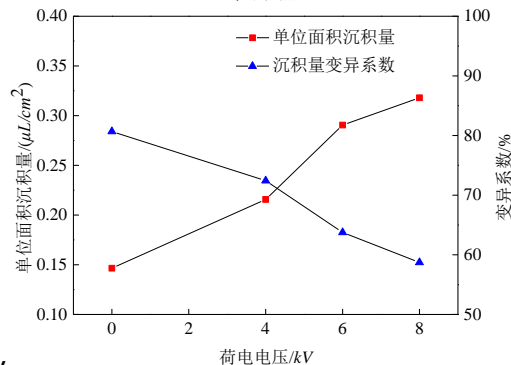
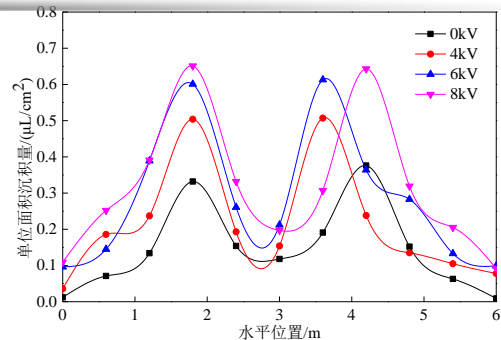


大载荷植保无人机喷洒技术

Large load plant protection UAV spraying technology



大载荷无人机的静电喷雾实验
Electrostatic spray experiments on large load UAV



结合静电喷雾技术，无人机两侧雾滴沉积量提升**60%**，均匀性提升**50%**。

Combined with electrostatic spray technology, the deposition of UAV on both sides of the drone is increased by 60% and uniformity is increased by 50%.

➤ 大载荷植保无人机工程应用

Engineering application of large load plant protection UAV



大载荷植保无人机在新疆地区的应用

Application of large load plant protection UAV in Xinjiang province



棉田喷洒作业

Spraying operation in cotton fields



枣林喷洒作业

Spraying operation of jujube forest

概述(Summary):

累计作业面积: **1818亩**

Cumulative working area: **1818 mu**

棉花: **1550亩**

Cotton: **1550 mu**

枣树: **168亩**

Jujube tree: **168 mu**

玉米: **100亩**

Corn: **100 mu**

节约用水量: **90%**

Saving water consumption: **90%**

作业效率: **1200亩/天**

Working efficiency: **1200mu/day**

用户评价: **可靠性高, 适应性强**

User evaluation: **high reliability and adaptability**

该植保无人机在新疆喀什地区销售量近百台, 产值超**亿元**。

This plant protection UAV has sold nearly **100** in Kashgar, Xinjiang, with an output value of over **100 million yuan**.



➤ 大载荷植保无人机工程应用

Engineering application of large load plant protection UAV



概述(Summary):

作业面积: **700亩**

working area: **700 mu**

每亩用药量(无人机): **430g/亩**

Pesticide consumption per mu (UAV):
430g/mu

每亩用药量(人工): **625g/亩**

Pesticide consumption per mu (manual
spraying machinery): **168 mu**

节约农药: **31.2%**

Save pesticide: **31.2%**

节约成本: $\geq 3\%$

Cost saving: $\geq 3\%$

大载荷植保无人机在江苏地区的应用

Application of large load plant protection UAV in Jiangsu province

用户应用报告显示,大载荷无人机植保作业效果理想,节省农药用量达**30%以上**。

The user application report shows that the effect of large-scale UAV on plant protection is ideal, saving pesticide usage by more than **30%**.





THANKS